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STEEL TOWERS FOR OVERHEAD TRANSMISSION LINES.

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It cannot be said that there is at the present time a standard type of steel structure for supporting the conductors of overhead transmission lines; neither is it likely that one particular design will ever be found suitable for all countries, climates and voltages. Any kind of supporting structure which will economically fulfil the necessary requirements will answer the purpose of the transmission line engineer, who merely requires a durable mechanical structure to carry a variable number of insulators at a height above ground, and with a spacing between them, depending upon the voltage of transmission and the length of span.

As a substitute for wood poles, steel tubes have been used, either in one piece, or built up of a number of pieces of different sizes in order to economize material and give a large diameter at the bottom where the bending moment is greatest, and a small diameter at the top where the bending moment is negligible. Steel poles of considerable height, suitable for longer spans, may be built up of three or four vertical tubes of comparatively small diameter jointed and braced together at suitable intervals to give stiffness to the structure. It is doubtful whether, in the long run, such composite tubular structures will hold their own against the latticed steel masts built up of standard sections of rolled steel, as used extensively on the continent of Europe, and, to a relatively smaller extent, in America. The term "tower" is applied mainly to the light steel structures in which the spacing between the main upright members, at ground leved, is large compared with the height of the structure; the usual proportion—which will generally be found to be the most economical in material—being 1 to 4; that is to say, if the base is square, the side of this square will be about one-quarter of the distance from the point of measurement to the top of the tower. If the towers are large, the footings are usually separate pieces which are correctly set in the ground by means of a templet, and to which the legs of the tower proper are afterwards bolted. A good example of large steel towers is to be found in the 100,000-volt transmission line of the Great Western Power Co. of California. Two three-phase circuits are carried on these towers, the vertical spacing between the cross-arms being ten feet. There are three cross-arms, each carrying two conductors—one at each end. The horizontal spacing between wires is 17 feet on the two upper cross-arms are 18 feet on the lower cross-arm, which is 51 feet above ground level. No conductor is closer than 6 ft. 5 in. to the steel structures, this being the minimum clearance in the horizontal direction. The average distance between towers is 750 feet, and they are joined at the top by a grounded guard wire 5 feet above the bottom of the highest cross-arm. The base of the tower measures 17 feet square, the parts under ground being separate pieces of steel, buried to a depth of 6 feet, to which the tower proper is bolted after being assembled and erected on site.

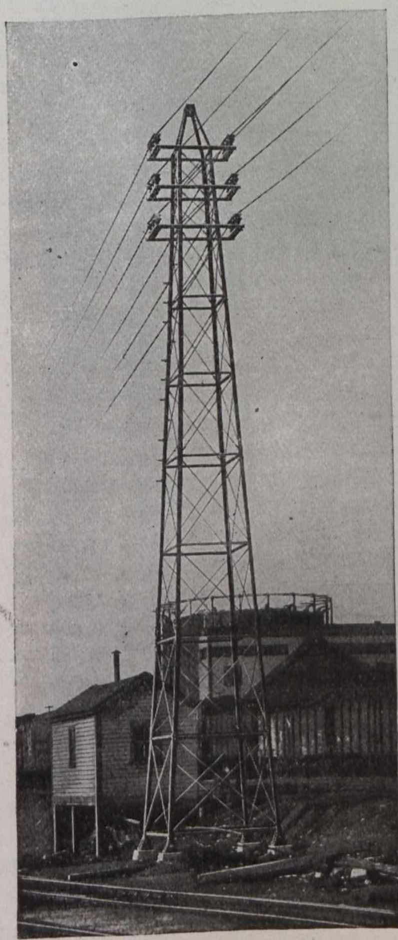

Fig. 1.

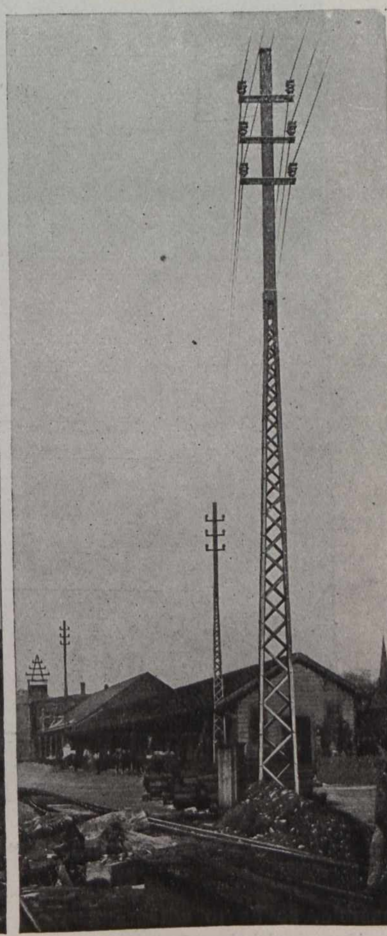

Fig. 2.

Fig. 2 shows the lighter form of latticed steel mast, while Fig. 1 is a corner tower on the same transmission

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line; it is generally similar to the standard towers with wide base, as used on straight rims for moderately long spans, except for the special arrangement carrying the larger number of insulators.

The term "tower" is also frequently applied to the "flexible" type of structure which has two main vertical members only, and is specially designed to have ample strength and stiffness in a direction at right angles to the transmission line, while it is free to bend, within certain limits, in a direction parallel to the line, without being permanently deformed. Great strength and stiffness in the direction of the line is not always necessary or desirable in a transmission line support; but it is obvious that the strength and stiffness must be sufficient to withstand the forces imposed on the structure during erection, and at the time of stringing the wires. A simple braced "A" frame steel tower of the "flexible" type is illustrated in Fig. 3. This photograph shows the steel and wood pole lines running side by side between Taylors Falls and Minneapolis, Minn. These towers are 42 feet high from ground level to bottom insulator, and have a standard spacing of 440 feet.

The maximum load which a tower must be designed to withstand will depend upon the number and size of wires to be carried and the estimated ice coating and wind velocity. Apart from the wind pressure on the structure itself, the loading in a direction transverse to the line will be equal to the resultant wind pressure on all the wires (which may or may not be ice coated, depending on the climate); the effective length of each wire being the distance between supports.

In the direction of the line the forces are normally very nearly balanced, but in the event of one or more wires breaking, the unbalanced load may be considerable, and it is well to design the towers, if possible, so as to withstand the stresses imposed upon them if two-thirds of all the conductors in one span are severed. On the other hand, it is not unusual to tie the conductors to the insulators in such a manner that the wire will slip, or the tie break before the conductor itself is stressed beyond the elastic limit of the material (about half the breaking load). It must not be overlooked that if the wires break in one span only, the cross-arm, if pin type insulators are used, will be subjected to a twisting moment; and if the break in the wires is at one end only of the cross-arm, the whole tower is subjected to tortional strain.

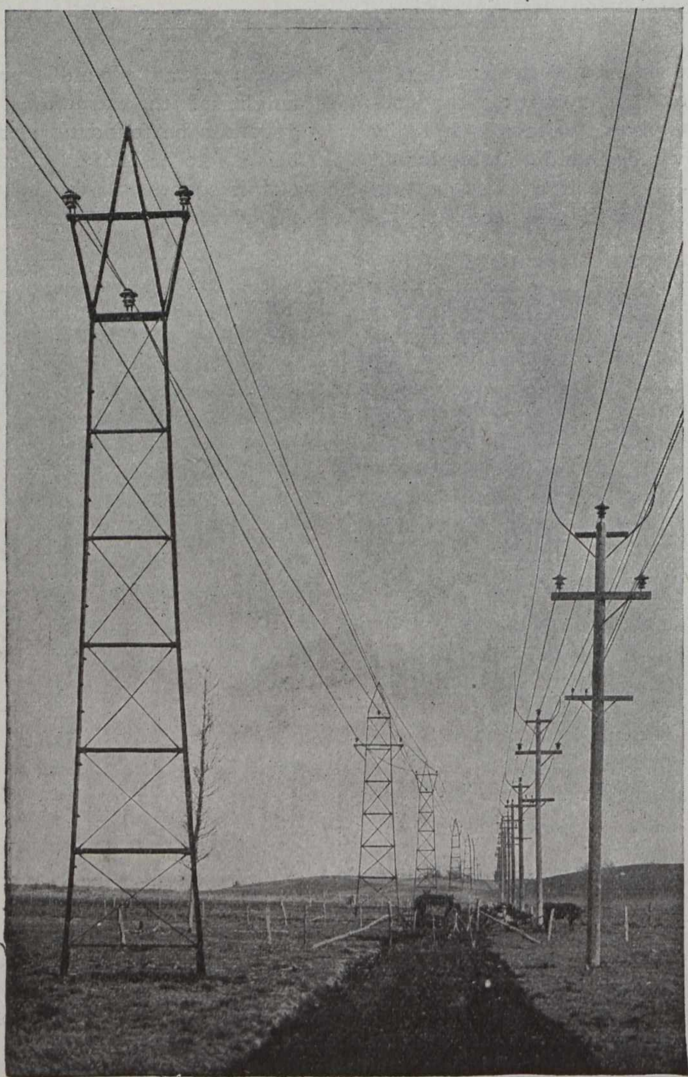


Fig. 3.—Simple Braced "A" Frame Steel Tower.

In Vol. XXV. (January to June, 1911) of the transactions of the Canadian Society of Civil Engineers, Mr. W. G. Chase gives some interesting particulars of the steel tower line from the municipal hydro-electric works of the city of Winnipeg at Point du Bois Falls. The supporting structures are of the "flexible" type, two designs being used, one for firm soil and one for swamp construction; the height being 42 feet. Braced towers are placed at intervals of about 1,200 feet and these were tested up to 6,200 lbs. applied at one end of the cross-arm 43 feet above ground in a direction perpendicular to the line. The test pull in the direction of the line was 7,200 lbs., corresponding to 1,200 lbs. per pin. The "flexible" towers are designed to have the same strength as the braced towers to resist wind pressures across the line, but they are intended to withstand only 480 lbs. in the direction of the line. The weakest point in the line is the wrought iron insulator pin which is intentionally designed to yield before the structure is damaged; these pins withstood on test a load of 1,500 lbs just before breaking. The towers carry six aluminum wires each of 278,600 circ. mils section. These conductors are tied securely to the braced towers, but on the flexible towers, the tie is designed to break with a pull of 80 to 100 lbs.; number 14 soft aluminum wire being used for the ties. This line is 77 miles long, and it transmits power at 66,000 volts.

The normal length of span on steel tower lines usually lies between 400 and 600 feet, but very much longer spans can be used where the character of the country would render their use economical, or where rivers have to be crossed. On the transmission system supplying Dunedin City, New Zealand, with electric energy at 35,000 volts, there is a span 1,700 feet long where the line crosses the ravine near the power station. The peculiarity of this span is the great difference in level between the two supports, the upper tower, which is a special steel structure, being 650 feet above the lower tower.

The 22,000-volt transmission lines of the Canadian Niagara Power Company cross the Niagara River near Buffalo in two spans, the longest being 2,200 feet long. The minimum clearance above water level is 131 feet, necessitating very tall supporting towers. These are of steel, arranged to carry nine 500,000 c.m. aluminum cables with a 15-foot spacing. An attachment consisting of a steel cable passing over a sheave and provided with counterweight, maintains a constant tension on the conductors and takes up variations in length due to changes of temperature.

On the high tension transmission lines of the Central Colorado Power Company, there is a single span 2,500 feet long. The St. Joquin River is crossed by a 3,000-foot span. The 100,000-volt lines of the Great Falls Power Company between Rainbow Falls and Butte, cross the Missouri River in a single span 3,034 feet long.

The longest span in the world is 4,200 feet across the Coquiney Straits.

The tower illustrated in Fig. 4 is 70 feet in height; it is used for supporting one end of a span about 1,000 feet long, where the transmission line crosses a river.

Having determined the maximum load to which the towers of a transmission line are likely to be subjected, it is usual to leave the strength calculations and details of design to the manufacturer; but the calculation of the stresses in the various members of a simple steel structure such as a transmission line tower, is comparatively easy, by making use either of graphical methods **(parallelograms of forces),** or the method of moments. A structure of this sort, when fixed to solid foundations and submitted to abnormal loads, is very liable to yield through the buckling of the members in compression, and the chief task of the designer is so to arrange and proportion the bracing and tying in of the compression members that the unbraced sections of these members shall not be unduly long.

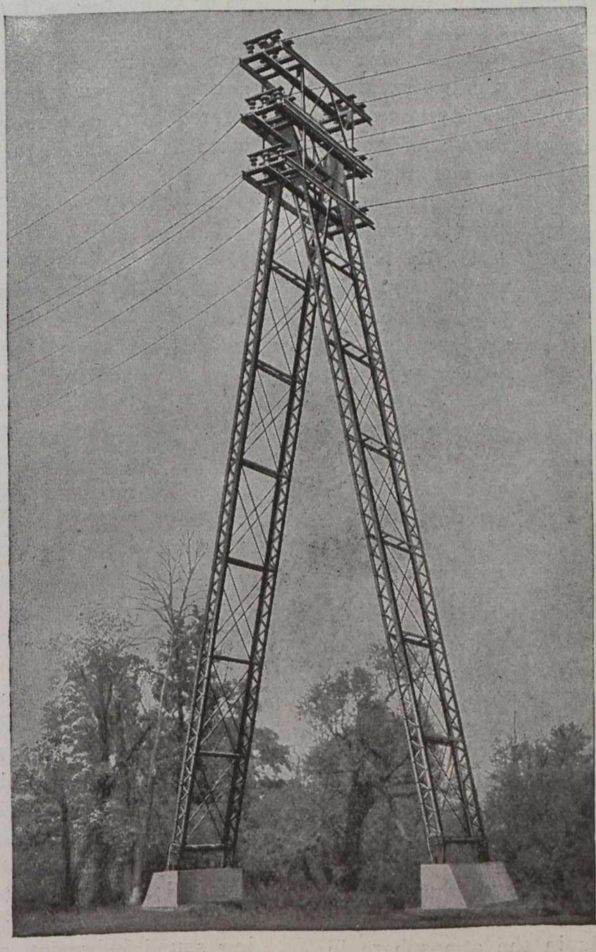


Fig. 4.—Steel Tower at River Crossing.

Rankine's formula for compression members is:

$$\frac{\text{Load}:}{\text{Area of Section}} = \text{lbs. per sq. Inch of Section} = \frac{T}{1 + C\dfrac{l^2}{R^2}}$$

Where T = maximum stress in metal in lbs. per sq. inch.

l = length of unsupported compression member.

R = least radius of gyration.

$= \dfrac{\text{moment of inertia}}{\text{area of section}}$, expressed in the same units as l.

C = a constant, which is about 1/25,000 for mild steel struts fixed at both ends.

By using the "straight line" formula, very similar results are obtained. For wrought iron angles and tees, with ends fixed, Burr gives:

Ultimate lbs. per sq. inch of cross section = 44,000 — 140 l/R, this value being multiplied by 1.25 for mild steel. To obtain working load, divide by factor of safety.

The "straight line" formula should only be applied when ratio l/R lies between 40 and 200, which corresponds to a length of compression member not exceeding about 20 times the width of flange.

When leaving the design to manufacturers, the specification for steel towers might with advantage contain a clause to the effect that the length of the compression members shall not exceed 200 times the least radius of gyration of the section. Also in the case of painted structures, it is best to allow no metal less than ¼ in. thick. If the metal is galvanized, it may be 3/16 in. and even as thin as ⅛ in. in the case of the secondary members. It is not usual to paint galvanized iron work, partly because the extra protection hardly justifies the expense, but also because ordinary paint does not adhere properly to a galvanized surface. Special paints can be obtained, but, generally speaking, the choice lies between a galvanized structure without paint, and a non-galvanized structure which must obviously be well protected with paint. The first cost of the latter is usually lower, but the coating of paint is not so durable as the galvanizing. Sometimes the parts in the ground only are galvanized, the rest being painted.

When a tower takes a "permanent set" under excessive load, this is often due to slight yielding of the joints before any buckling of compression members takes place.

In regard to the factor of safety to be allowed in the design of steel towers, a factor of three is sometimes called for, and this is a safe figure; but it is usually sufficient to allow a factor of two under the severest expected conditions of loading; which means that, under such conditions, the structure would be stressed to the elastic limit. This factor of safety probably corresponds to a factor of about five under normal conditions of wind and ice loading; moreover, it is unnecessary to allow a very large factor of safety in such structures because abnormal stresses are nearly always moderated by the slipping of the wires in the ties, the slight yielding of the foundations or joints, or similar movements which tend to relieve such abnormal stresses as might otherwise wreck the supporting structures.

The deflection, or movement of the top of a steel tower under load is usually small, and unless the towers are specially designed of the "flexible" type, the strain is rarely sufficient to modify the tension in the wires to any appreciable extent. The design of steel tower line with the object of providing considerable elastic yielding of the supports in the direction of the line, is a special and rather difficult problem which has been dealt with by other writers, and also elsewhere by the present writer.*

The deflection of the top of a transmission tower of the ordinary light "windmill" type with wide square base, when bolted to rigid foundations and subjected to a horizontal load such as to stress the material up to nearly the elastic limit, might be from two to five inches, while the more slender latticed masts of the type shown in Fig. 1 would have a greater deflection.

The following table, which gives the deflections of built-

* "Electrical World," Vol. 60, No. 2, page 97, July 13th, 1912.

up tubular steel poles of the type shown in Fig. 5, has been compiled from some interesting figures published in the "Standard Handbook" for electrical engineers.

D_1	t_1	D_2	t_2	D_3	t_3	Weight of pole (lbs.)	Maximum horizontal (load elastic limit)	Deflection (inches)
10	1/2	8 5/8	3/8	7 5/8	9/32	1342	2800	5.572
9	7/16	8	11/32	7	9/32	1099	2000	6.020
8	3/8	7	5/16	6	1/4	846	1600	7.852
7	5/16	6	1/4	5	3/16	600	900	8.217

When making comparisons between wood and steel for transmission line supports, it is not only the matter of first cost that has to be considered. Steel structures have the advantage of being invulnerable to prairie and forest fires; moreover, owing to the longer spans rendered possible by the stronger and taller supports, there is less chance of stoppages owing to broken insulators, and less leakage loss over the surface of insulators. A fact that is often overlooked is that the size of conductor limits the practical length of span; for instance, with a small conductor such as a No. 4 B. & S., it would not be wise to have spans much above 250 or 300 feet. This suggests what is frequently found to be the case, namely, that the total cost of a line may be reduced by using a conductor of rather larger section than the electrical calculations would indicate as being necessary because the stronger cable permits of a wider spacing of the supporting towers.

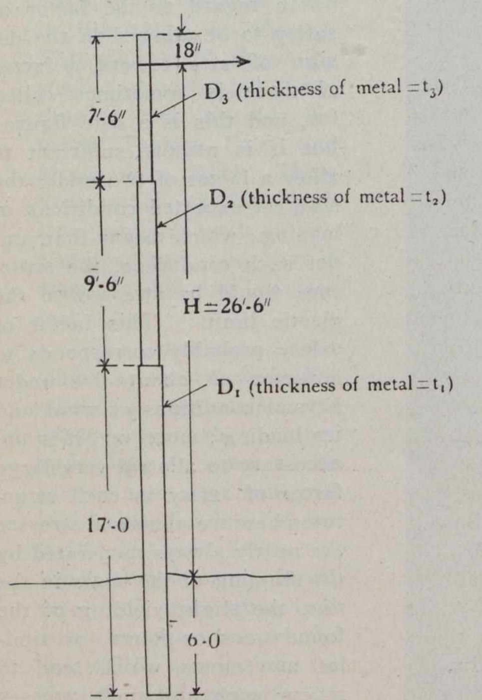


Fig. 5.

The life of a steel tower line depends somewhat on climatic conditions. In Great Britain the dampness of the climate, together with the impurities in the atmosphere in the neighborhood of manufacturing and populous districts, render light steel structures less durable than in America (except, perhaps, on the Pacific coast, where special precautions are required to guard against rapid corrosion due to the prevalence of fogs and moisture). Not only has the iron work protected by paint to be repainted on the average every three years, but the spans must usually be short, as the private ownership of valuable property renders the construction of a straight transmission line with long equal spans almost impossible in the United Kingdom. These conditions are all in favor of the employment of selected and well creosoted wood poles, the life of which may be 30 years or more.

It is well to test the quality of the galvanizing on steel towers before erection. This is readily done by immersing samples in a solution of sulphate of copper (specific gravity about 1.185) maintained at a temperature of 60 to 70 degrees Fahr. After remaining in the solution one minute, the sample should be removed, thoroughly washed in water, and wiped dry. This process should be repeated four times, after which there should be no red spots indicating copper deposit.

The nature of the foundations necessary for steel towers will depend on the height of the tower and the pull to be resisted. In unsuitable soil it may be necessary to use concrete blocks to which the legs of the tower can be anchored; but in solid ground the concrete can generally be dispensed with. The shape and depth of the footing under ground must be such that the weight of concrete (if any) and the weight of packed earth shall be sufficient to prevent the upward pull due to the maximum horizontal load at the top of the tower.

A factor of safety of two is usually allowed. The weight of concrete may be taken at 140 lbs. per cubic foot, and of good earth at 100 lbs., the volume of the earth to be lifted being calculated at the angle of repose, which may be about 30 or 33 degrees with the vertical, as indicated in Fig. 6. If the footing of a tower is in gravel or a mixture of sand and loam, tightly packed, there is actually a far greater resistance to the pulling up of the footings than that which is offered by the mere weight of the footings with prism of earth as calculated the usual way.

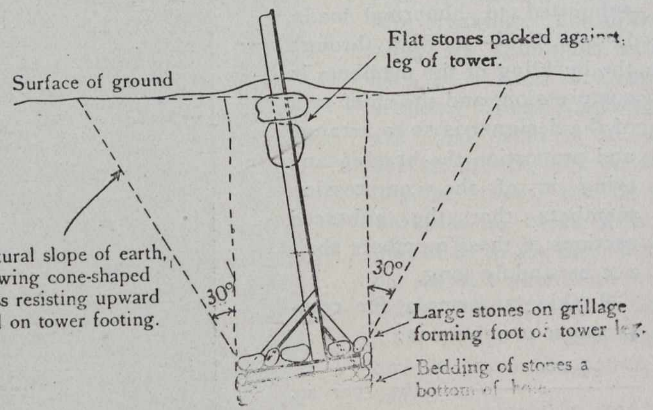


Fig. 6.

When concrete has to be used, it is generally cheaper to reinforce it with steel of an inverted T form, as this makes a lighter construction than a solid block of concrete, and an equally good hold is obtained owing to the increased weight of the packed earth which has to be lifted. In marshy or loose soil, or where the right-of-way is liable to be flooded, special attention must be paid to the design of durable foundations. Concrete footings with or without piles, or rock-filled cribwork may be necessary; it is a matter requiring sound judgment, and preferably previous experience on the part of the engineer in charge of construction. Crumbling hillsides are best avoided; it is extremely difficult to guard against damage by landslides or even snowslides when towers are erected on the steep slopes of hills.

The Hydro-Electric Commission of the Province of Ontario, Canada, have a total exceeding 280 miles of high tension line, supported on steel towers spaced on the average 550 feet apart. They use concrete only where necessary. The standard double circuit tower measures just over 56 feet from ground level to the top. The leg angles with steel footings are buried not less than 7 feet in good ground. In rock, a footing of concrete is usually made to level up the four feet of the tower, and holding down bolts are let into the rock to a depth of not less than 2 ft. 6 in. and grouted in. When a deep footing is necessary in poor soil, the concrete block for each leg will measure about 1 ft. 9 in. square at the top and something over 3 foot square at the bottom, with a base about six inches thick and four feet square, the total depth being approximately 7 feet, with only a small portion—usually less than a foot—appearing above ground level.

Steel towers are usually shipped in sections and assembled on the ground before erection. Sometimes they have to be erected in pieces from the ground up, but usually the structure is stiff enough and light enough to allow of the complete tower being raised from the ground by using a team of horses and the necessary poles with block and tackle.

The illustrations of steel towers and structures which accompany this article have been kindly furnished to the writer by the Archbold-Brady Company, of Syracuse, N.Y. The photographs represent the latest American practice in steel pole line construction.

A STADIA IN GEORGIAN BAY, DISTRICT OF PARRY SOUND.

A stadia survey affords a quick and accurate method for the location and mapping of land. Mr. A. G. Ardagh, in a paper presented to the Association of Ontario Land Surveyors gives a description of the methods used on a stadia survey in Ontario.

Instructions for this survey were dated March 19th, 1910, and the survey was temporarily commenced a few days later. It was the intention of the Surveys Branch to have base lines for triangulation measured on the ice in preparation for the summer survey, and this could have been accomplished if the exceptionally warm weather of March in last year had not rendered the ice unsafe. I had hoped to use the ice to run a closed transverse completely around the district assigned to me, and at the same time leave bases for triangulation. An attempt to do this was made, but accomplishment was defeated by the state of the ice.

The survey was definitely commenced on April 18th. The backbone of the survey was a run of triangulation along the main open channels closing on itself, now and then, where the channels made this possible. The bases were measured with a 5-chain tape, wherever the ground was suitable. Such places were not easily to be had except at the outer reefs, and they varied from 5 chains to 20 chains in length. Starting from a measured base, the length of the next base was calculated trigonometrically, and compared with the actual measurement of the new base, which gave a check on the work in between. All angles were read singly and then doubled, as a check both upon sighting and reading, and all three angles of the triangle were read and totalled to 180 degrees. The instruments used were a D.L.S. Watt Transit, 6-in. diameter, a Bausch & Lomb 4-in. (a very fine instrument), with a Foster for spare. The instruments only read to minutes, half minutes being estimated; adjustment was frequently necessary to the angles. The bearings were checked by astronomic observation every now and then, with an error of a minute or two. For plotting, the latitudes and departures of the main courses were calculated. In two instances in cycles of triangulation of 15 miles each the error in the lats. and deps., as calculated, was over 1/10th of one per cent. Although in the arrangement of pickets, selection of angles, etc., no great precision was aimed at, but only quick, practical results, yet I do not see the necessity for an error of this amount, and believe it was not wholly due to merely cumulative error. All township posts found on the mainland were tied in by triangulation.

The man doing the triangulation had a small board on which he plotted the triangles to scale on sheets. The angles were adjusted, if necessary, and the bearings and sides calculated following round each triangle and checking back on the first side. The triangulations points were indicated by the Greek letter Δ and the turning points by the letter "T." Where more than one transit is engaged on the stadia work, each transit man should have his subscript to prevent confusion where the same numbers are used by each man, and the numbers should be marked on the pickets.

The stadia transitman takes the copy of the triangulation sheets with him that affect the part he is working in, and where passing triangulation point, sets up at it and checks and corrects his bearings thereby. I think the stadia wires are best adjusted at 10 chains, so that exactly ten links are read on the rod. There will be a slight error over and under this distance, but of no practical account in intermediate readings.

Apart from the triangulation, the work consisted of a multitude of short shots, and for this the stadia wires appeared to be most apt and quickest, although I had a micrometer with me. The shots might average 8 or 10 chains, and rarely went up to 20 chains, even on turns. The transitman reads the rod and enters the distance first, reading his vernier while the rodman moves on, and no second instrument has to be consulted.

Stadia parties consist of three—transitman, rodman and steerman—the two latter together in a canoe. At first I furnished the transitman with a skiff, but latterly found that no time was lost by having the canoe men come back for him, as they had plenty of time to do it while he checked his bearings, marked his picket, made his sketches and got ready to move.

The Watt instrument read four ways to 90 degrees and one way from zero to 360 degrees, so that readings could be taken either in quadrants or on azimuth; the latter is less productive of error, as occasionally the wrong quadrant is entered in the notes, and in any case it is one more tax on the mind. The Bausch & Lomb could only be read on azimuth, and so some of the readings had to be converted in the office to quadrant bearings. To obviate reduction as much as possible, the readings were entered both ways from north to south with this instrument. Although errors in quadrant may generally be detected in plotting, yet a little time in the field may save a lot of worry in the office, and it is important to be sure of the bearings of the traverse before you pick up your instrument. The following, I think, is a good method of ensuring accuracy: Having brought the instrument from the last turning point with vernier clamped and lower limb free, sight on the back point, seeing also that the vernier has not shifted, and after taking intermediates, set the forward point, then turn again on the back point and see that lower limb has not shifted since setting up, then set the vernier at the forward reading and note if the wire intersects the picket. It has happened that where the instrument has been carried clamped from one station to another, the bearings have checked out on closing the traverse, but owing to reading of one course having been entered wrongly, the work would not plot. We don't need to be told how to do work nearly as much as we need to have hammered into us that any neglect of system to effect a temporary saving of time will make us pay dearly in the end.

The loose-leaf system was employed and found satisfactory. Holders with strong springs and which fitted easily into the pocket were used. The field notes were drafted to scale. The scale first adopted was too small and necessitated the enlargement of portions. The northerly part of the work was drafted to a scale of 4 chains, and even this cramped the notes, as the exhibited sample will show.

Search was made for township posts along the coast. The township of Harrison was surveyed thirty years ago, the surveyor now being deceased. The country has been burnt over, or both timbered and burnt, and a great many of the posts have been destroyed. The original blazed trees were found in some instances. We made a stadia survey of the coast which, based on the triangulation, produced a good result. Following the indentations of the shore, we surveyed 95 miles of main coast line, mostly in one township. The original coast line of Harrison is more or less imaginary, no actual traverse having been made in the original survey.

The islands were marked by either substantial posts or blazed trees, and the number of the island painted on the rock in white. Roman numerals were used by instructions. This was done in advance by a party of two, who also kept a list of islands and posts, and described the unpatented islands, while the notes of the transit party following after furnished a final check and the position of the tree was tied in by distance and bearing. This was the work of a moment when the rodman was passing it. Any items overlooked in the proper order consumed a lot of time afterwards in picking them up.

STEEL HIGHWAY BRIDGES.

Mr. Neal Garver, instructor in structural engineering at the University of Illinois, stated in a paper presented before the Illinois Society of Engineers and Surveyors some months ago that during several years' experience in bridge work with a large company he had observed on more than one occasion that the contractor did not attempt to slight either the fabrication or erecting work on railroad bridges, but in the case of a highway structure far less care was exercised on many occasions.

In the construction of small steel highway bridges, it is an exception to inspect the steel before it leaves the fabricating plant, which Mr. Garver regarded as a mistake. There are many details, some of considerable consequence, which can be easily remedied at the shop, but are difficult or expensive to change in the field. For example, some ¼-in. lacing bars were used on a bridge where 5/16-in. bars were required. In another case, Lomas nuts of the same size were used for 3 and 3¾-in. pins; the nuts were all standard size for the 3-in. pins, but for the 3¾-in. pins the recess in the nut was insufficient to pass over the shoulder of the pin. In still another case the specifications required all finished surfaces to be painted with white lead and tallow before leaving the shop. This was mentioned on the shop drawings. It was further required that the masonry and shoe plates on which the expansion rollers moved should be planed. The pins were unpainted and had become quite rusty, the rollers had been painted with a heavy black paint, and the masonry and shoe plates were unplaned. This structure was a 120-ft. span with adjustable counters in the trusses. In order to have the required net sections, the screw ends should have been upset, but they were not. On a five-panel 80-ft. pony-truss span the shop drawings called for the two end panels of each of the trusses to be riveted up complete and the members of the middle panels field-riveted. Instead of being shipped as required, the bridge was sent out completely knocked down, no two members being riveted together. All riveted joints on the two end panels had been computed for shop rivets; the specifications under which the bridge was inspected required the allowable shear on field rivets to be reduced 20 per cent. below that on shop rivets, so that by this failure to follow directions the efficacy of the new bridge was made only 80 per cent. of what it should have been.

Mr. Garver is of the opinion that many of the weak points in small steel highway bridges, due to defects of erection, can be traced directly to the foreman. He believes that poorly driven steel rivets are to be found on practically every highway bridge job. Well-driven rivets require both care and experience, qualifications usually lacking in the foremen for such work. It is not unusual to find rivet holes filled with cement and painted over. Turned bolts furnished for highway bridge work are often machine or pressed bolts turned down about 1/16 in. smaller than the rivet hole and not to a driving fit, as required by specifications. Real turned bolts are turned out complete from the steel bar.

The packing of pins is often carelessly done, and sometimes the foreman is hardly to blame for this because no sketches are given on the drawings to indicate in what order the bars are to be placed on the pins. Without such a sketch it may happen that the bending moment on the pin will be much greater than it was calculated to receive. Constant trouble is experienced in forcing the foremen to place collars on the pins to keep the bars in their proper positions in the tension members of the bridge.

In the design of highway bridge details, a common point of weakness is the connection of the floor beams to the posts, which is lacking in rigidity. Sometimes the post is so detailed at this point as to reduce its efficiency materially in taking compressive stresses. For example, the post may be made up of two channels laced, and the floor beam suspended below the bottom chord. The channels are cut off above the bottom chord eye-bars to clear the eye-bar heads and only narrow plates are extended down to carry the floor beam. The omission of any provision to carry the outside end joists where they come close to the shoe and cannot rest on the masonry is often observed in plans.

Mr. Garver's suggestions for improving highway bridge work are as follows:

1. In states having highway commissions the highway engineer should get up standard shop drawings for all spans in common use. The drawings should be carefully checked, all poor details eliminated and all mistakes corrected.

2. All fabricated materials should be carefully inspected by an experienced man before being shipped from the fabricating plant. This will eliminate all shop errors, intentional or otherwise, and provide first-class work to go into the field.

3. The work should be carefully inspected in the field after erection and before its acceptance.

4. All companies bidding on this class of work should be given due notice of what to expect, so there can be no complaint of its enforcement.

5. Mr. Garver believes that there is only one price basis fair to both parties concerned, and that is a pound-price basis.

6. The bids should be called for, not for a single bridge at a time, but for the steel bridges for the entire state for a full year, on a pound-price basis, bids being called for on each class of work, with a maximum and minimum tonnage to be ordered under those bids. The objection to this system might be that it would eliminate the small bridge companies. The time has arrived, Mr. Garver considers, when economy should be practised in public as well as private affairs, and it is quite certain that private corporations would not use the methods that have been in vogue generally in the management of public business. If the small bridge companies can do as good work at the same price as the larger concern, they would not necessarily be eliminated.

GRADE REDUCTIONS ON THE T. & N. O. RLY.

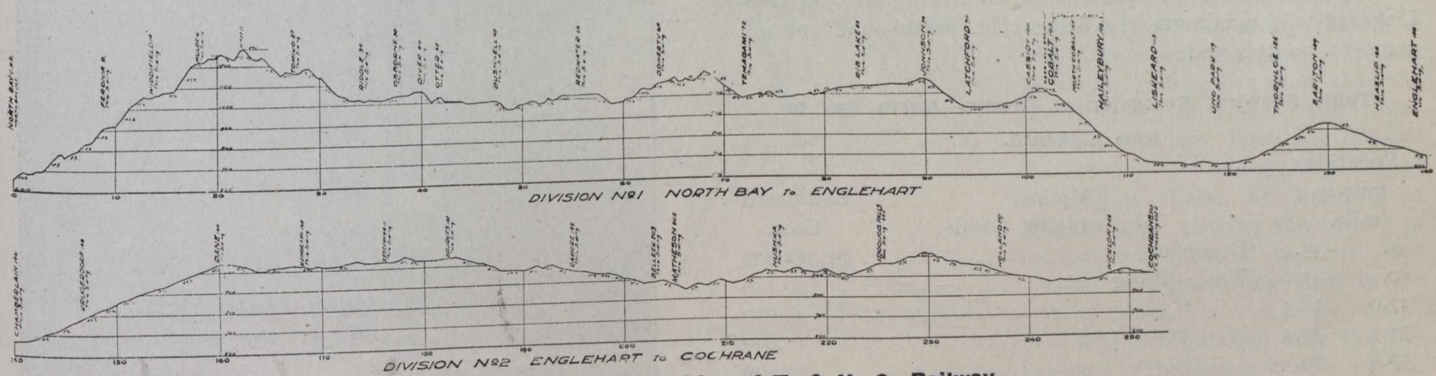
The following discussion on the question of grade reduction on the T. & N. O. Railway is abstracted from a report by the chief engineer, Mr. S. B. Clement, to the T. & N. O. Railway Commission contained in the annual report of the commission:

The main line of the T. & N. O. Railway between North Bay and Cochrane is a natural connecting link, between the Grand Trunk Railway of Eastern Canada and the Grand Trunk Pacific Railway of Northern Ontario and Western Canada. That this is so, is manifested by the fact that the G.T.R. is now negotiating with the Commission for the privilege of routing its through, passenger and freight traffic to and from the G.T.P. Railway via the T. & N.O. Railway.

That section of the T. & N.O. Railway between North Bay and New Liskeard was located as a colonization railway and placed under construction before the National Transcontinental was projected. Later when N.T.C. Railway was decided upon, it became apparent that if the T. & N.O. Railway were to be extended from New Liskeard to a connection with the N.T.C. Railway it would receive from the latter a large volume of traffic in addition to what would be developed with the growth of the country, opened by the T. & N.O. Railway itself. The maximum grades on this new N.T.C. Railway were understood to be 0.4 per cent. against eastbound and 0.5 per cent. against westbound traffic, with all

	North Bay to New Liskeard.	New Liskeard to Cochrane.
Distance	112.6 miles	140.0 miles
Ruling Gradient—North Bound	1.45 %	0.5 %
South Bound	1.2 %	0.4 %
Maximum Curvature	6°	4°
Curvature per mile	83°18′	27°56′
Tonnage Rating (10 wheel class)—		
North	560 tons	1,460 tons
South	700 "	1,710 "
Maximum Tonnage Rating (New Consolidation Class)—		
North	1,070 tons	2,700 tons
South	1,290 "	3,160 "

A very large proportion of the operating expenses necessary to handle a given traffic varies directly as the number of trains it is necessary to operate. Any increase in the trainload, whether resulting from a reduction in the ruling grade or an increase in the power of the locomotives, will reduce the train mileage, and proportionately decrease the operating expenses. In general, it has been well established that capital expenditures on grade reduction are economically justifiable and to be recommended, whenever the resulting reduction in operating expenses is greater than the interests on the capital expenditure.



Profile of Main Line of T. & N. O. Railway.

grades fully compensated for curvature, the sharpest curves being 4°. The same standards of grades and alignment were adopted by the Commission for the extension of the T. & N. O. Railway from New Liskeard to the Transcontinental Railway. As actually located, however, the maximum grades on the National Transcontinental Railway are 0.6 per cent. against westbound traffic, instead of 0.5 per cent. The maximum grade on the T. & N.O. Railway between New Liskeard and Cochrane is therefore slightly less than the maximum grade against westbound traffic on the National Transcontinental Railway.

Uniform and definite maximum grades do not appear to have been adopted or rigidly adhered to at the time of the location and construction of the section between North Bay and New Liskeard. In general, grades in both directions up to 1 per cent. not compensated for curvature, were freely used on all portions of this section while 1.25 per cent. grades not compensated were used in several places between North Bay and the summit in Merrick Township at M.P. No. 23. The ruling grades over the first division therefore, are equivalent to 1.2 per cent. south bound, and 1.45 per cent. north bound when compensated for curvature, curvature as sharp as 6° having been freely used on maximum grades.

The difference between the physical characteristics of the two sections of the railway is strikingly shown in the following table:

During the year a series of surveys was completed that had been carried on intermittently since 1906, to determine to what extent it was practicable to reduce the excessive grades between North Bay and New Liskeard. The shorter and lighter of these grades can be reduced without changing the alignment while the longer and heavier can only be eliminated by rebuilding on a new location, in some cases at a considerable distance from present right of way. Wherever these diversions have been necessary actual locations have been made and estimates of cost prepared.

The most striking feature of the accompanying profile of the T. & N.O. Railway is what is locally known as the "Merrick Summit," just north of North Bay. The elevation of the North Bay yards at the C.P.R. Junction is 652 ft. above sea level and from Riddle north for 25 miles, the general elevation of the country is approximately 1,000 above sea level. The intervening "Merrick Summit," with an elevation of 1,300 ft. above sea level, is the most serious obstacle to be overcome. In the original location, this summit was crossed by deflecting several miles to the east from North Bay, following the rugged shores of Four Mile Creek, and the North River to the summit. After an exhausted examination of the country on both sides of the right of way, it was found that a lower grade from North Bay could be obtained by following Duchesnay Creek and the summit could be crossed at an elevation of about 1,170 ft. or about 130 ft. lower than the present summit, connecting with the present line at M.P. No. 35, just north of Riddle. If at all possible, it is desirable, that the ruling grades on the first division should not exceed those on the second division, but it is a physical impossibility to obtain an 0.5 per cent. grade north from North Bay. This diversion, North Bay to Riddle, has been located with maximum curvature of 4°, and with maximum grades of 0.8 per cent. northbound and 0.6 per cent. southbound, all compensated for curvature. The cost of construction will not be excessive. The diversion gives the lowest grade that can be obtained from North Bay without swinging the line far to the west to the Sturgeon River Valley. With this diversion as a key to the situation it will be unprofitable to attempt to lower the grades between Riddle and Liskeard below 0.8 per cent. northbound and 0.6 per cent. southbound.

Having adopted these ruling grades, every grade in excess of them, between North Bay and New Liskeard, was carefully examined. It will not be necessary to reduce a number of the shorter of these grades as they may be operated as momentum grades. The reduction of the grade between New Liskeard and Cobalt from 1 per cent. to 0.6 per cent. can only be accomplished by a diversion that would pass at a considerable distance from the present station grounds, at Haileybury and New Liskeard. For this reason, it is advisable, for the present, to overcome this grade by means of a helper engine service.

The following summary statements show the proposed method of reducing all grades between North Bay and New Liskeard to a maximum of 0.8 per cent. northbound and 0.6 per cent. southbound:—

Table Showing Reduction of Grades—North Bay to New Liskeard.

Location, mile to	mile.	Method of Reducing Grade.	Estimated Cost.
2.	35.	Diversion	$1,482,500
40.	41.2	Train filling	50,120
47.9	48.5	"	25,610
51.7	52.5	"	11,000
57.8	59.	"	39,100
60.4	61.8	"	33,280
62.5	63.3	"	9,200
66.7	73.2	Diversion	367,675
74.5	75.3	Train filling	16,225
90.	94.	Diversion	220,000
100.	100.5	Train filling	8,400
101.	112.	Helper Engine Service	....
		Total	$2,263,110

The total length of the North Bay-Riddle diversion will be thirty miles, replacing thirty-three miles of present line. The curvature on diversion average 71°, and on the present line 93° per mile.

The total rise and fall is as follows:

	Rise.	Fall.
Present main line	747	374
Diversion	634	258

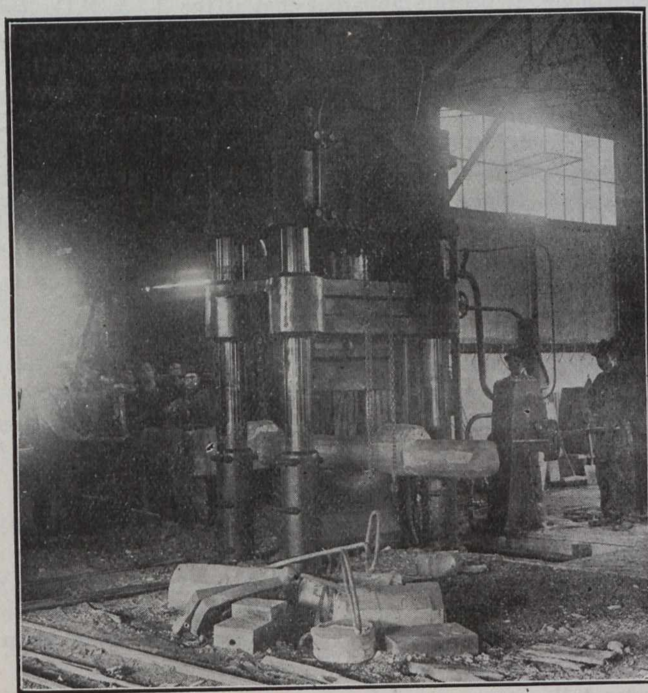
Professor W. W. Andrews, of Regina, is engaged in making a study of the coal and clay deposits of the southern part of the province for the Saskatchewan government. In connection with the fuel problem the professor has succeeded in making briquettes from lignite and also from straw. In regard to the latter he claims that out of 800 tons of straw he can manufacture 300 tons of straw briquettes, which will be equal in all respects to the best firewood.

A NEW FORGING PRESS.

There has recently been installed at Welland, Ont., by the Canada Foundries and Forgings, Limited, in the Canada Forge plant, a high-speed hydraulic forging press of German design. The press was built in the United States and is one of the first of its kind in Canada.

The problem which this new press has been designed to solve is that of forging the metal by pressure instead of by repeated hammerings. Heretofore, the process of shaping the metal to its different forms has been accomplished by hammer, in which the hammer head, urged at high velocity, beats the mass of metal into shape by a series of blows. This process naturally is accompanied by tremendous shock and vibration.

The new high-speed hydraulic forging press recently installed by the Canada Forge Company, operates at shorter range. It kneads the metal by a press head, which, after



View of New High-Speed Hydraulic Forging Press Installed by Canada Foundries and Forgings, Limited, Welland, Ont.

being brought into contact with the metal, is urged by tremendous force, which works the mass not only at and near the surface, but through to its centre. The new press is a 500-ton one, and, being of the hydraulic type, is more efficient than the steam press. Water pressure at 3,000 pounds per square inch is supplied by high-speed pumps driven by A.C. motors direct connected.

Serving the press are two electric gib cranes, one on either side, which carry the billets from the two large furnaces especially constructed for the purpose. A third large furnace is now being installed for annealing and heat-treating carbon and alloy steels.

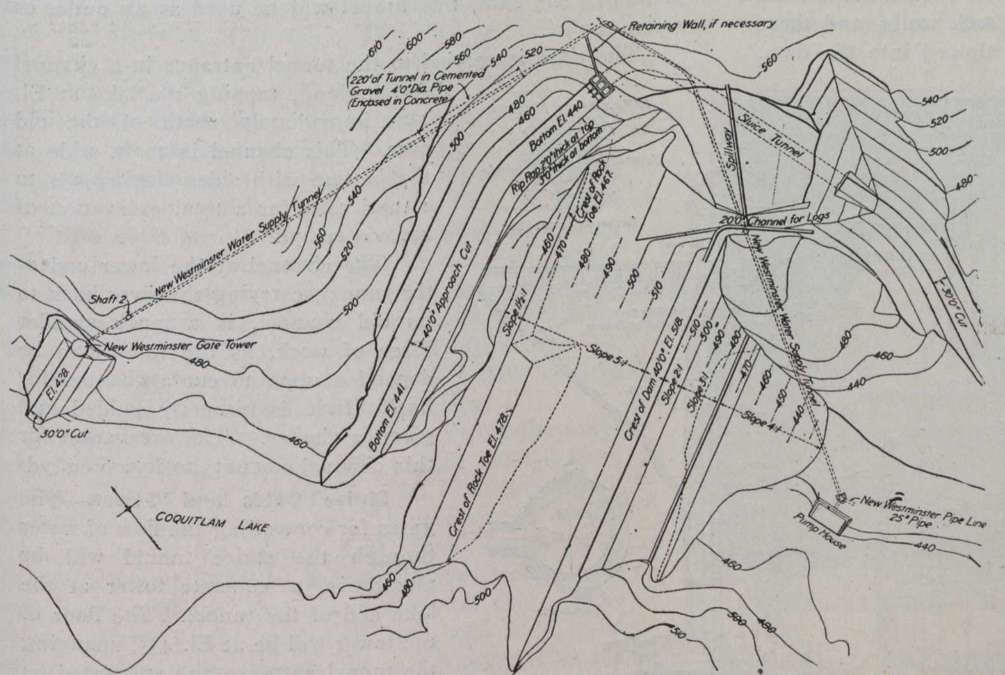
An interesting electric, modern welding equipment has recently been installed in the Canadian Billings & Spencer plant, also at Welland, which concern is another of the subsidiary companies of the Canada Foundries and Forgings. This electric welding equipment is used constantly on automobile and carriage work, for which it is especially adapted. The company is also carrying out extensions in order to put into operation a new five-thousand-pound steam hammer early next year.

THE COQUITLAM-BUNTZEN HYDRO-ELECTRIC POWER DEVELOPMENT.

The Coquitlam-Buntzen Water Power System is owned and operated by the Vancouver Power Company, Limited, a subsidiary company to the British Columbia Electric Railway Company, Limited, operating in the city of Vancouver, British Columbia, and the surrounding towns and districts over an area of 1,600 square miles. Mr. Charles A. Lee, assistant engineer of the Vancouver Power Company, describes the enlargement of this development in an article published in a recent issue of the Engineering Record, from which the following details are taken. This power system was first put in operation in December, 1904, replacing a steam plant which had been used up to that time.

The Buntzen power house is at sea level on the east side of the North Arm of Burrard Inlet, about 16 miles from Vancouver. The original installation consisted of four 1,500-kw. generators driven by Pelton water wheels. Water is supplied to the wheels through steel penstocks from Lake Buntzen, the north end of which is only 1,700 ft. from the power house. This end of the lake is the outlet end, and a concrete dam, 54 ft. high, was built across the creek, raising the level of the lake to 397 ft. above sea level, thus giving a mean head of about 390 ft. at the wheels. The penstocks are connected to steel pipes built in the dam at El. 378. These pipes are 4 ft. 6 in. in diameter, and the flow of water in the penstocks is controlled by roller-bearing sluice gates over the openings on the lake face of the dam. These gates are placed behind suitable racks and are operated from the crest of the dam. Ten openings for penstock connections were built in the dam to provide for future extensions of the power house.

Watershed.—The area of Lake Buntzen is about 500 acres, and this lake is used as a reservoir to supply water for the immediate needs at the power house. By the use of flash-boards across the spillway the lake level can be raised to El. 400, and it can be drawn down to El. 388 when it is so required, thus giving an immediate available supply of 6,000 acre ft. The Lake Buntzen watershed has an area of about 7 sq. miles, and the run-off is, therefore, light, excepting during the rainy seasons, when at times it reaches several thousand cubic feet per second. The main supply of water is drawn into Lake Buntzen from Coquitlam Lake through a tunnel connecting the two lakes.



Location Plan of Earth Dam and Rock Tunnels for Power Development.

The Coquitlam Tunnel is 12,650 ft. long, driven through the solid granite ledge separating the two lakes. It was designed for carrying 500 cu. ft. per second, but actual gaugings showed a flow of only slightly over 300 cu. ft. per second. The tunnel was unlined, and had a mean section area of 81 sq. ft.

Coquitlam Lake lies directly to the east of Lake Buntzen, and is separated from it by a ridge of mountains rising over 5,000 ft. above sea level. This lake is about 7 miles long, and has an average width of 2,500 ft., and an area of about 2,330 acres. The watershed area is 105 sq. miles. The original elevation of the lake surface was 432 ft. above sea level, but a rock-filled timber crib dam was built across the mouth of the Coquitlam River at the south end of the Lake, raising the lake surface to 443 ft. above sea level.

When the system was first put in operation in 1904, it was thought that ample provision had been made for any extension of the power house for some years to come, but the rapid development and growth of the country soon made it evident that the demand for power would, in a very few years, exceed the maximum capacity of the development.

After a careful investigation it was decided that the existing development could be enlarged to utilize almost the entire run-off of the Colquitlam watershed, at less expense, and in less time, than the development of a new water power project. It was, therefore, decided to increase the storage capacity of Coquitlam Lake by building a higher dam, enlarge the tunnel to obtain the required capacity, and install new generating units in the power house.

The precipitation over the Coquitlam watershed averages 156 in. per year. The winter snows are heavy and remain in the higher parts of the mountains until late in the summer, thus forming a splendid natural reservoir. The average run-off is very close to 1,000 cu. ft. per second, the co-efficient of run-off being between 75 and 80 per cent. There are short periods during the winter and summer months when the run-off drops considerably below the normal, but there are no extended dry periods such as is the case further inland.

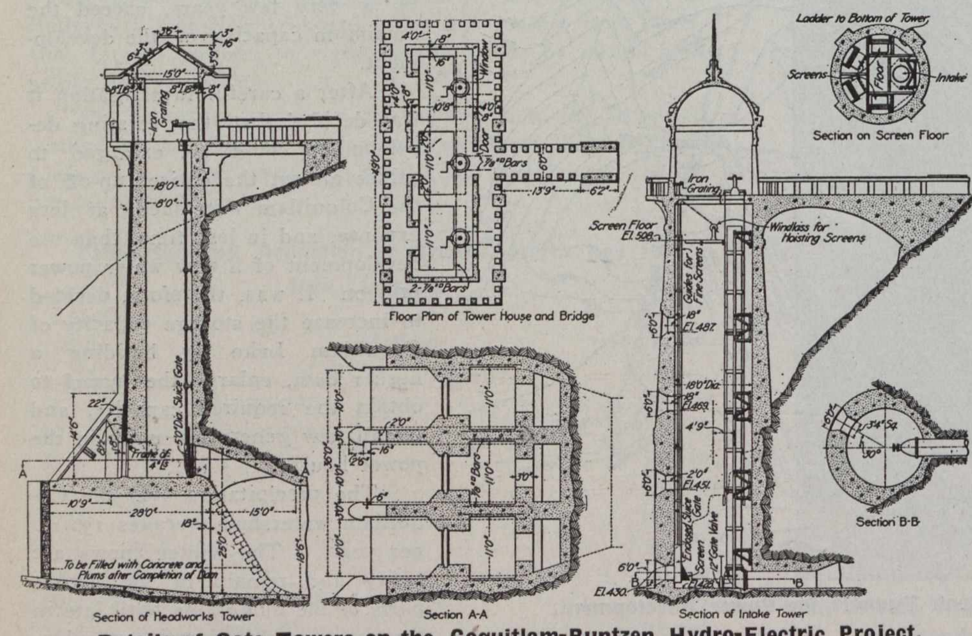
Coquitlam Dam.—In order to obtain sufficient reservoir capacity to store practically the entire Coquitlam run-off, it was decided to build a dam just below the existing timber crib dam, which would raise the lake level 60 ft. and increase the capacity of the reservoir by 162,000 acre ft. This will give a total available storage when the reservoir is full of nearly 175,600 acre ft., or 7,562,000,000 cu. ft.

The dam site is at the extreme southern end of the lake. On account of the geological formation, it was considered impracticable to build a masonry dam. Bed-rock lies so far below the surface of the valley that it would be impossible to get a rock foundation, and the hydraulic earth fill type was adopted on the recommendation of Mr. James D. Schuyler, M. Am. Soc. C.E., who acted as consulting engineer until all the original plans for the dam had been prepared.

The new dam is being built upon a great natural dam thrown across the valley at this point by the receding glacier, and is made up of fine blue glacial boulder clay, and tightly cemented gravel and boulders. Excellent construction material, in large quantities, is available and the borrow pits can be located in the most advantageous positions.

The city of New Westminster draws its water supply from Coquitlam Lake, and in order to safeguard its interests during the construction of the dam, and to approve of the final plans of the dam and the new waterworks intake, the Dominion Government appointed Mr. John R. Freeman, M. Am. Soc. C.E., to represent their interests under the agreement entered into between the Dominion Government and the Vancouver Power Company.

The completed dam will have a length on the crest of 850 ft. The crest is at El. 518, and has a width of 40 ft. The upstream slope is 5 to 1 from the crest to El. 467, and from there to the toe the slope is 1½ to 1. The downstream slope is 2 to 1 from the crest to El. 500, 3 to 1 from there to El. 475, where there is a berme 6 ft. wide, and from the berme to the toe the slope is 4 to 1. The extreme height of the crest above the lower toe is 98 ft. At both the upstream and downstream toes there are heavy rock walls, and these will confine and support the material sluiced into the dam.



Details of Gate Towers on the Coquitlam-Buntzen Hydro-Electric Project.

Both slopes are covered with riprap 3 ft. thick, the upstream riprap being laid in concrete up to above the normal water level. The total volume of the dam is 530,000 cu. yd., of which 132,600 cu. yd. are rock used in the toe-walls and riprap and the remainder is sluiced material. There will be no core wall of any kind, and water-tightness will be secured through the great thickness of puddle keyed into several shallow trenches. The dam will be built almost entirely on tight blue glacial clay, which is quite impervious and forms a splendid foundation. The east end of the puddle keys into a deep trench sunk to the surface of the granite ledge which slopes at a steep angle towards the centre of the glacial valley.

Spillway Section.—The spillway will be located at the east end of the dam, and will be cut through the spur of ledge, so as to be entirely in rock and separate from the dam. The width of the cut at the entrance is 250 ft., and tapers to 185 ft. at the lower end in 150-ft. length. The concrete sill at the entrance to the spillway will be at El. 503, 15 ft. below the crest of the dam. A channel 20 ft. wide and 7 ft. deep will be cut along the west side of the spillway and will be used for the removal of logs and drift which may gather in the lake at the dam. This channel will be provided with a movable dam so that no water need be wasted unless required. Ths capacity of the spillway will be 12,000 cu. ft. per second when the water is 7 ft. deep over the sill. The spillway cut will necessitate the excavation of over 75,000 cu. yd., about 53,000 of which will be rock.

Outflow Tunnel.—During the construction of the dam the outflow from the lake will be carried around the dam site through a tunnel driven through the ledge under the spillway. This tunnel is 490 ft. in length, and has a sectional area of 400 sq. ft. The clear width is 26 ft., and the height is 18 ft. 6 in. to the centre of the roof, which is semicircular in form. The floor and sides, to a height of 12 ft., will be lined with concrete. The floor of the tunnel entrance is at El. 435, and slopes to 425 at the lower end. The tunnel was designed to carry 12,000 cu. ft. per second, when the lake surface is at El. 475, but will probably never be called on to carry much more than half of this, as the above quantity is the maximum recorded rate of run-off. After the completion of the dam, this tunnel will be used as an outlet or sluice tunnel.

The river is carried to the tunnel entrance in a channel 860 ft. long, tapping the lake at El. 443, immediately north of the old dam. This channel is 40 ft. wide at the bottom with sides sloping 1½ to 1, and calls for a total excavation of 202,000 cu. yd.

The channel at the lower end of the tunnel, carrying the river back to its old channel, is a much smaller piece of work, as the water can be depended upon to cut a channel for itself if it is properly guided and given a chance. The excavation for this channel amounts to 80,000 cu. yd.

Sluice Gates and Tower.—The gates for controlling the flow of water through the sluice tunnel will be placed in a concrete tower at the lake end of the tunnel. The floor of the tower will be at El. 455, spanning the tunnel entrance and supported on two piers placed parallel to the flow in the tunnel. Guides are provided at the upstream end of the piers for three gates, made up of 15-in. I-beams and heavy timbers, and these gates will be dropped into place when the dam is completed, thus closing the tunnel entrance. The space between the floor of the tower and the floor of the tunnel will then be filled with concrete and plums, permanently closing the upper end of the tunnel, excepting through the sluice gates. The tower is rectangular in form, built up of three separate compartments 8 by 11 ft., each one independent of the others. It is built back in the cut at the tunnel entrance, so that the back wall and side walls are against the rock for three-fourths of their height. The tower is surmounted by a concrete gate-house surrounded by a balcony at El. 513. A short concrete bridge connects the balcony with the shore of the lake. The main sluice gates are 5 ft. in diameter, and are placed in the back wall of the tower at the floor level, discharging directly into the tunnel. The openings in the front wall can be closed by auxiliary gates made up of I-beams and timber, and operated by chains from the gate house balcony. It is only intended to use these auxiliary gates for inspection of the main gates. Inclined racks are built against the front wall of the tower, protecting the gates from water-logged timber or other trash which might be drawn into the tower. Since the building of the dam and the consequent raising of the lake level rendered the New Westminster waterworks intake useless, it became necessary to construct an entirely new intake system. The new intake structure is a heavy concrete tower built on a spur of bedrock on the east side of the lake about 1,000 ft. north of the dam. The floor of the tower is at El. 428, and the floor of the concrete gate house at El. 518. The tower is circular in section, with an inside diameter of 18 ft., top and bottom. The walls are 4 ft. 6 in. thick from the bottom to El. 465, and taper to 18 in. at the top. A concrete arch bridge connects the tower with the shore. There are four 40-in. square intake openings in the tower placed at Els. 430, 451, 469 and 487, at angles of 60 deg. to each other. The openings are belled to the outside and covered with racks 6 ft. square. Gates are secured over the openings on the inside of the tower, and since these gates are subjected to back pressure only, tending to force the disc away from its seat, it was necessary to build them of special design. The cast steel gate disc slides in vertical guides, but the gate seat and the back of the gate are at a slight angle to the direction of travel. The disc is, therefore, wedged tight to the seats when in the lowest position, the guides taking the full thrust of the pressure of the water against the back of the disc. In all other positions of the disc the seats are not in contact; hook wedges are provided at the top and bottom of the gate to hold it against the seat. The seats, and all wearing surfaces, are lined with gun metal. These gates are enclosed in a sheet steel box having an opening directly in front of the gate opening over which the fine screens are placed. These screens are made up in teak wood frames and are lowered into position by means of a hand winch placed on the screen handling floor at El. 508. The screen frames slide in channel guides secured to the tower walls by brackets and anchor bolts.

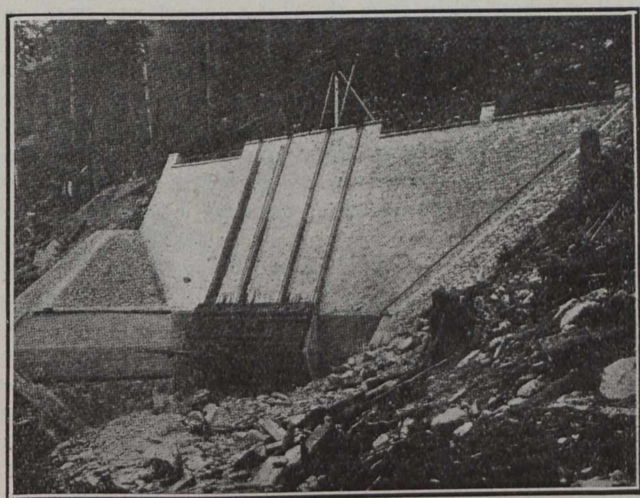
A secondary intake is placed entirely within the tower whereby the water may be drawn off at any desired level. This intake consists of a stand pipe 42 in. in diameter built up in four separate sections, each section having conical seats on the upper and lower ends, each section seating on the one next below it, and the bottom section seating on a heavy cast iron elbow set in the tower floor. The intake pipe sections are guided between two 60-lb. rails placed on opposite sides of the pipe and bracketed to the tower wall at frequent intervals. Lifting rods 1½ in. in diameter are attached diametrically opposite near the top of each pipe section. This intake is operated by hand by means of a lifting gear which may be attached to any set of lifting rods.

The openings in the intake pipe are at Els. 433, 451, 473 and 481. A channel 20 ft. wide at the bottom, with side slopes 1½ to 1, is cut from the base of the tower to deep water in the lake.

From the intake tower the water enters a tunnel 1938 ft. long around the east end of the dam, and connects to a distributing chamber near the lower toe of the dam. This chamber is supplied with a blow-off valve and pipe connections. The tunnel is all in rock excepting for a distance of 508 ft., which portion is lined with steel pipe 4 ft. in diameter encased in concrete. The tunnel in rock is 4 ft. wide by 6 ft. 6 in. high, and only the floor is lined with concrete.

Construction Methods, Excavation.—The construction of the Coquitlam dam was started in the winter of 1908. The whole of the dam site was covered with heavy virgin forest, and it was necessary to clear about 60 acres before other construction work was started. During the winter of 1909 the pumping plant was installed, and in the spring of 1910 the stripping of the dam foundations and the excavation of the diversion channel were started. All of this excavation work has been done by the hydraulic process and this method has proved very successful for the greater part. While working in the upper parts of the cut in the boulder clay banks, with a flume having a grade of over 3 per cent., as high as 11,000 cu. yd. of material were removed in one week, about 120 hours actual working time, using one jet delivering 10 cu. ft. per second at a pressure of 110 lb. per sq. in. at the nozzle. This record just cited is considerably above the average, but serves to show what can be done under proper working conditions.

In the excavation at the lower levels, a great deal of difficulty was experienced because of the very low flume grades and the heavy materials encountered. It became necessary when excavating the bottom of the diversion channel to use hydraulic gravel elevators to raise the sluiced materials from the floor of the channel to the flume level, a height of from 5 to 12 feet, depending on the distance the flume end extended into the cut. This flume was run on a grade of only 2½ per cent., and it was necessary to use great care in the grading of the sluiced materials so that they would not drag and clog the flume.



Completed Tunnel Intake, Showing Trash Rocks.

The flumes used in all of the excavation work are of rectangular section 20 in. wide. They are built of 1½-in lumber and are unlined on the sides. The bottom is lined with ¼-in. steel plates secured by countersunk screens and 2 x 4-in. strips nailed along the bottom corners. The lower end of each plate lapped over the one next below it about 3 in. This lining proved to be quite satisfactory, as the wear comes almost entirely on the bottom of the flume and the plates can easily be removed and replaced when worn out.

Practically all of the excavation was done in heavy boulder clay and in tightly cemented gravel and large boulders. The clay was easily handled, as it could be bored and shaken up with powder and then broken up and removed by the jet. The cemented gravel had to be treated quite differently, as it was almost impossible to bore and shoot it, and it would have required a very powerful steam shovel to handle it. It was found that a high pressure jet at close range made better progress than any other available method. Wherever it was possible to drill and shoot, this was done, but only shallow holes could be put down on account of the tendency of the drill to loosen the gravel and stick.

In these excavations a large quantity of boulders were uncovered which could not be run through the flumes. These were loaded into cars with a dragline bucket, with derricks or by hand, and dumped into the rock walls forming the toes of the dam.

The excavation for the New Westminster intake tower was made behind a cofferdam built out into the lake at that point. This dam consists of a timber crib filled with rocks and clay, having sheet piling driven along the face of the crib into the silt forming the lake bottom. The volume of this excavation was 10,000 cu. yd., 8,500 of which was sluiced and elevated from the pit by a hydraulic gravel elevator. The height of lift varied from 23 to 36 ft. At the greater lift, a 3½-in. stream under 125 lb. pressure was used in an elevator having a 10-in. throat. This method proved very satisfactory.

Tunnel Driving.—Both the sluice tunnel and the water supply tunnel were driven by contractors. Two shafts were sunk along the line of the water supply tunnel and it was worked from several faces. One of the shafts will be lined with concrete and used for inspecting the tunnel. The sluice tunnel was driven from the upper face and also both ways from a break-up directly over the point where it crosses over the water supply tunnel. This tunnel was driven with one heading and a bench. The heading included the whole tunnel above the springing line, 28 ft. wide on a 14-ft. radius, and the bench was 5 ft. deep. Most of the rock removed from the water supply tunnel was wasted, but all of that taken from the sluice tunnel was used in building up the toe walls of the dam.

The material overlying bedrock in the spillway cut was removed by the hydraulic process and the rock is being quarried out and placed in the dam toe walls by two cableways. The sluicing of material into the dam was started this summer. The borrow pits are placed in an advantageous position where the choice of material is large and the grades are good.

The original pumping plant supplying water for the sluicing operations consisted of two motor-driven centrifugal pumps of 4 cu. ft. per second capacity each, one of them operating against 50 lb. per square inch, and the other against 150 lb. per square inch. This plant has been increased by the addition of one motor-driven centrifugal pump delivering 4 cu. ft. per second against 150 lb. per square inch, and two motor-driven centrifugal pumps delivering 5 cu. ft. per second each against 150 lb. per square inch. The compressor plant consists of two motor-driven compressors delivering 400 cu. ft. per minute at 100 lb.

Power is obtained from the Lake Buntzen power house. The line supplying the dam taps the company's line six miles south of the dam site. The current is transmitted at 34,000 volts and transformed at the dam site to 2,200 volts, at which pressure it is used.

Enlargement of Coquitlam Tunnel.—It was absolutely necessary to leave Coquitlam Tunnel open for a large part of the time in order to maintain a supply of water in Lake Buntzen, and this made the actual working time in the tunnel very uncertain and of short duration. During the summer months more than half the time was lost in this way on account of the very light run-off from the Lake Buntzen watershed.

The work of enlarging the tunnel was started from the Lake Buntzen end in November, 1908, but the company took over the work in December, 1909.

The method of enlargement adopted by the company's engineers was the "overhead" method, which consisted of taking out enough rock on each side of the tunnel near the roof to set heavy timbers along close to the roof, wedging these timbers across the tunnel and also supporting the ends on wall plates and posts placed against the tunnel sides. These timbers were placed about 6 ft. apart, and a floor of 6 x 8-in. timbers was laid loose upon them close up to the tunnel roof. By means of this system of timbering a heading was driven above the tunnel, using the timber floor as the floor of the heading. In this way the work could be carried on in both directions from as many "break-ups" as was practicable. The several headings were mucked into cars on the track in the tunnel below by withdrawing the floor timbers and opening up the floor directly in front of the muck pile. The timbering was kept well ahead of the faces and left standing for some distance behind them. During the first part of this work horizontal holes about 6 ft. deep were drilled into the face of the heading in the usual way, but on account of the hardness of the rock and the heavy charges of powder necessary to make a clean break it was almost impossible to make the timbering of sufficient strength to stand the blow. The method of drilling was, therefore, changed and vertical holes were drilled from the tunnel below before the timbering was put in, keeping the drilling well in advance of the face. This system of drilling and shooting proved satisfactory, as the force of the shot did not act downward on the timbers, but threw the muck back from the face.

This method of enlargement gave the tunnel a section much the same as an egg held with the point down, with an area of 176 sq. ft.

Some very fair work was done under this system after the crew was well broken in, but there was one difficulty which it seemed impossible to overcome. The timbering cut down the area of the tunnel to such an extent that its capacity was considerably decreased. This made it necessary to leave the tunnel open for a greater part of the time than would have been necessary otherwise, in order to keep the level of the water in Lake Buntzen above the lower limit, and, therefore, less time was available for work in the tunnel. The greater the number of headings worked the greater was the obstruction in the tunnel, as timbering was necessary at every heading. The demand for water was increasing daily in spite of the fact that the company had built a steam plant in the city and had relieved the Lake Buntzen power house of 4,000 kilowatts of its load.

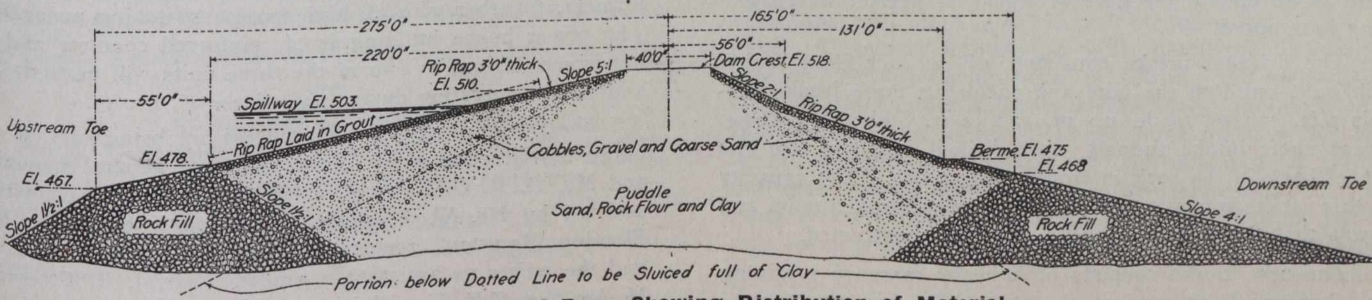
In July of 1910 the "overhead" method was abandoned in favor of one which necessitated no timbering. At this time about 1,800 ft. of enlargement had been completed and the tunnel was drilled to a point 3,000 ft. from the portal. Before changing over the drilled portion was completed by the first method.

Drilling and Mucking.—The method by which the remainder of the tunnel was enlarged consisted of removing sufficient rock from one side and the roof to increase the area from the original 81 sq. ft. to 192 sq. ft. The side headings were started at intervals of from 100 to 130 ft., and were worked in both directions. The drilling was all done from the main tunnel at right angles to the line of the tunnel. The holes were drilled 8 ft. deep, and were placed in vertical rows spaced 3 ft. apart, each row having five holes. Two rows of holes were drilled from one setting of the drill column mounting two drills on horizontal arms, one on each side of the column. The drilling was carried on independently of the shooting and mucking, and was kept well ahead of these two operations. When the "break-outs" were first started and were narrow between the faces, only one row of holes would be shot on each face, but two rows were shot on each face after the headings had widened out sufficiently to accommodate the muck pile without spilling it out over the tracks in the old tunnel. As many as 14 "break-outs" were worked at one time, giving 28 working faces. This operation removed the rock from the side of the tunnel, and the roof was trimmed up by a separate gang following the first. The heavy shots in the side of the tunnel broke out well into the middle of the roof, and it was often necessary to do very little trimming. After the side holes had been shot and mucked a small, gang followed with stoping drills and drilled the roof where it was necessary.

The work was carried on in the tunnel as long as the water in Lake Buntzen was above the minimum level. When this level was reached the tunnel was opened and allowed to remain open until the lake was filled again. Two ten-hour shifts were worked in the tunnel. All of the drilling was done on the day shift, and the shooting was done when the drilling shift went off duty.

When the night crew came on the two tunnel locomotives took the men as far as the first face, where they started to clear the track of all muck. As soon as the track was cleared the cars were spotted at each of the faces and the mucking was carried on as quickly as possible and the tunnel cleared ready for the day shift and drills.

The muck was hauled in 1⅓-cu. yd. side dump cars, which were handled in the tunnel in trains of 25 to 30 cars by electric locomotives of 40 h.p., taking current at 500 volts from a trolley wire hung from the roof of the enlarged tunnel. The trains were run on schedule time, having regular passing points. There was also a telephone in the tunnel, and any delay was reported and the passing points of the trains changed accordingly. Side tracks 500 ft. long, for the passing of trains and the storage of cars, were built in the enlarged tunnel every 1,000 to 1,200 ft. The track was laid on 36-in. gauge and constructed of 20-lb. rail. Two



Cross Section of Dam, Showing Distribution of Material.

lighter locomotives were used for handling the cars outside of the tunnel on the dump and making up trains for the tunnel locomotives.

The muck was all dumped into Lake Buntzen, which is very deep at the tunnel entrance. The dumping tracks extended down the shore from the tunnel for a distance of about 1,000 ft. On account of the tendency of the dump to slide under the weight of the loaded cars, it was carried out on two levels and the tracks were kept some distance apart. By this arrangement the cars could be dumped from the upper track while repairs were being made, or the track shifted on the lower dump.

Drainage and Ventilation.—When the gates at the Coquitlam end of the tunnel were closed it was necessary to wait for some time before the tunnel was sufficiently free of water to allow the workmen to enter. In order to better this condition, an automatic shutter dam was placed in the tunnel at station 72+00. This dam was pivoted on its horizontal axis and closed automatically when the water was 4 ft. deep, thus storing the water to that depth behind the dam, allowing the lower end of the tunnel to clear quickly. When the gates were again opened and the water raised, the dam swung so as to be parallel to the flow of water, offering no resistance to the flow.

The original tunnel was not driven straight through on one grade, but sloped from El. 400 at the Buntzen portal to El. 410 at station 72+00. From there it sloped to El. 407 at station 119+00 and to El. 428 at the Coquitlam end at station 126+45. There therefore existed a sump nearly 5,000 ft. long near the Coquitlam end of the tunnel, where the maximum depth of water was about 4 ft. It was at first intended to enlarge this portion by shooting down enough rock from the roof of the tunnel to fill the sump and bring the floor to true grade, thus having a dry tunnel to work in, but this plan was rejected in favor of placing a large motor-driven centrifugal pump at the Coquitlam end of the sump and pumping the water from the sump back into Coquitlam Lake. The pump was set up in a water-tight compartment blasted out of the side of the tunnel. The pump motor was started from above shortly after the gates were closed and the sump pumped dry in a very short time. The method of enlarging the tunnel from the summit, through the sump, and to the gates at the Coquitlam end, was the same as that used up to the summit.

The tunnel being open at both ends, it was a comparatively easy matter to ventilate and clear out the powder gases. A large motor-driven blower of 56,000 cu. ft. per minute capacity was placed at the Buntzen portal. After the shooting was done the portal was closed and the blower started, and all gases were cleared out within 30 minutes.

Drills and Drilling Gangs.—No. 7 Water Leyner drills were used almost exclusively in the work of enlargement, and the work done by these machines is exceedingly creditable. They averaged something over 40 ft. of hole per machine per day of less than 9 hours actual drilling time. most of the machine men were not experienced Leyner men, and they were often prejudiced against that drill, but they learned rapidly and soon came to like the machines. The greatest number of drills in use in the tunnel at one time was 54, not counting the stopers, which numbered from 3 to 7.

Each drilling foreman had charge of four machine crews. Upon going off shift, the drill foreman loaded all of his machines and steel on the train and took it to the repair shop, where the machines were gone over by the repair crew during the night, and any necessary adjustments were made. In this way the machines were always kept in first-class order. On going into the tunnel each morning each drill crew attended to the loading of their machines and sharp steel. One repair man was kept in the tunnel on the drilling shift and any slight repair or adjustment could be made at once. The steel sharpening was done by three Leyner sharpeners working two shifts of ten hours. One temperer on each shift tempered all the steel.

Air was furnished to the drills by two compressor plants, one at each end of the tunnel. The Buntzen plant consisted of one Ingersoll-Rand and four Leyner motor-driven compressors having a total capacity of 2,250 cu. ft. of free air per minute. The Coquitlam plant consisted of two Ingersoll-Rand motor-driven compressors having a capacity of 500 cu. ft. of free air per minute. Both of these plants fed into a 5-in. diameter air main running the whole length of the tunnel. Water under pressure was furnished to the drills through a water main laid parallel to the air main.

The tunnel enlargement was completed in March, 1911, in less than 100 working days after the side method of enlargement was started. The average advance per day of two shifts during this time was very close to 100 ft. of enlargement. The maximum advance for one day was 175 ft., when 730 cars of muck were hauled out of the tunnel. The maximum number of men at work at one time was 450. Serious accidents to the workmen were very rare occurrences. On most work of this character accidents are almost the rule, but on this work only one man was killed by rock falling from the tunnel roof, and two were injured by a "missed hole."

Tunnel Intake.—When the tunnel enlargement was started a 9-ft. diameter Coffin sluice valve was put in the tunnel a short distance downstream from the old gates. This valve was placed in the tunnel at the bottom of a shaft sunk from a tunnel which was driven above the proposed high-water level of Coquitlam Lake and was designed to operate under 85 ft. of head.

When the tunnel enlargement was completed the Coffin gate was taken out and re-set about 40 ft. upstream in place of one of the original sets of gates, and the old gates were removed entirely. In the place of the Coffin gate two Stoney roller bearing sluice gates were installed. These gates are each 4 ft. 6 in. wide and 10 ft. high. The Coffin gate is set in a Venturi throat and the tunnel is concrete lined between the Coffin and the Stoney gates. The Stoney gates will be used as the usual operating gates, and the Coffin gate as an emergency gate or whenever perfect watertightness is required.

The original intake consisted of a rock-filled timber crib built out into the lake and enclosing three intake tunnels 7 ft. square, made up of 12 x 12-in. timbers set close. These short intake tunnels were joined together into one tunnel back in the rock in front of the gates. The capacity of this intake was not sufficient for the enlarged tunnel and it was therefore torn out and a new one constructed.

The new intake consists of a heavy masonry retaining wall inclined back against the steep hill above the tunnel entrance, the elevation of the top of the wall being above the proposed high water level. The bottom of the wall is on bed rock and it is 50 ft. wide at the tunnel entrance. The main wall is flanked by two inclined wing walls extending diagonally out into the lake from the back wall. Four rails are laid vertically up the face of the back wall from below the tunnel entrance to the top of the wall, and these rails form the track to the racks. The racks are mounted on eight wheels and are made up of a heavy framework of I-beams supporting a "gridiron" of 40-lb. rails laid vertically a few inches apart. The gate operating gear is placed in the upper tunnel and the gates are geared to be operated by either electric motor or gasoline engine, or they can be operated by hand.

The rack is 41 ft. wide and 35 ft. high, and is supported by heavy cables, counterbalanced that it can be raised and and cleaned at any time, and operated by a power winch. In case any very heavy drift gathers in the forebay it can be removed by a heavy stiff-leg derrick which is placed on the top of the retaining wall.

Power House.—Since the original installation of four 1,500-kw. generators at the Lake Buntzen power house the capacity of this plant has been increased three times, each time by the addition of one 15,000-kw. generator driven by a 10,000-h.p. impulse waterwheel. The present capacity of this plant is 21,000 kw. in generators driven by waterwheels, totaling 42,000 h.p. Three-phase, 60-cycle current is generated at 2,200 volts. Four separate waterwheel and motor-driven exciter units furnish the excitation current for the main generators. The equipment is complete with all switches, instruments, etc., but the transformers and high tension apparatus are placed in a separate building. The power house is a native granite building and the transformer house is constructed of reinforced concrete. The current is stepped up in the main transformers to 34,000 volts, at which voltage it is transmitted to the various sub-stations around Vancouver.

No further extension can be made to this plant without going to great expense, and the company now has under construction a separate power house at a point about 1,800 ft. south of No. 1 plant.

This new power house, known as "Lake Buntzen Power House No. 2," will draw water from Lake Buntzen through a concrete-lined tunnel 14 ft. 8 in. in diameter and 1,750 ft. long. A concrete surge tank is built at the lower end of the tunnel, and the water is conveyed from the tank to the power house, a distance of 600 ft. down the hill, through three heavy steel penstocks 8 ft. 6 in. in diameter.

Power House No. 2 will be equipped with three generators of 8,900 kw. capacity driven by 13,500-h.p. Doble impulse wheels. Each generating unit is complete with a 300-kw. waterwheel and motor-driven exciter. Three-phase, 60-cycle current is generated at 2,200 volts and stepped up to 60,000 volts in the main transformers, at which voltage it is transmitted to Vancouver. The equipment of this power house will be complete in every way and of the most modern and approved design, and will include 36,000 kw. in transformers, together with all high tension switching apparatus. The power house building is of reinforced concrete and of handsome design. Two of the three units will be installed and put in operation during the winter of 1912-13.

The works at present in progress are being carried out under the direction of Mr. R. H. Sperling, general manager, and Mr. G. R. G. Conway, chief engineer of the company, assisted by Mr. W. V. Hunt, hydro-electric engineer; Mr. Fleming Ramsaur, resident engineer at Coquitlam Dam, and the writer as assistant engineer. Mr. J. R. Freeman, M. Am. Soc. C.E., is advising engineer for the Dominion Government, and Mr. R. S. Stronach is inspecting engineer, acting under instructions from the Water Powers Branch of the Department of the Interior.

A NEW BRITISH FACTORY FOR DIESEL ENGINES.

In spite of the progress which has been made by Continental engineers in the construction of Diesel engines it is of considerable interest to note that extensive Diesel engine works are being built as Ipswich by the Consolidated Diesel Engine Manufacturers, Limited, London. This will be the first large factory in Great Britain devoted exclusively to the manufacture of Diesel engines for ship propulsion as well as for stationary purposes.

Situated in a most convenient and accessible quarter of the town, with lines from the Great Eastern Railway running direct into the buildings, the new works will be equipped completely with the latest types of machinery and plant for first-rate workmanship. From the inauguration employment will be given to several hundred workmen; and provision has also been made to secure additional land in order to cope with the increasing demand for Diesel engines. All preparations are well in hand, and it is anticipated that the works will be in full swing in the early part of the coming year.

Mr. W. T. Batho, managing director of the Consolidated Diesel Engine Manufacturers, Limited, is in Toronto this week and expects to go on the Coast before returning to England.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL. MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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CONTENTS OF THIS ISSUE.

CITY GOVERNMENT BY COMMISSION.

The justification for government by city council will fast disappear if many men of the type indicated by the following statement are elected municipal office. An alderman in one of our larger cities the other day made the statement that the day should never come again when the judgment of experts should be considered infallible, especially when the expenditure of immense amounts of money is involved. To secure economy in carrying on the industrial affairs of a city the work necessarily must be in the hands of experts. Until this fact is thoroughly understood by the public, inefficiency and waste must follow the present system. Prof. Slichter, of the University of Wisconsin, in a recent address on the present tendencies of this age, states that perhaps the greatest mission of science and industrialism to our era is the removal of controversy from human progress. This is, indeed, a great service to mankind—to narrow the field of strife, to remove obstacles, to settle great public matters by bringing to bear accurate data, adequate analysis of cause and effect, and expert judgment—so that contention, or partisanship, or politics, is eliminated, and things are settled on their merits. This phase of the industrial age is fast developing. The numerous expert commissions appointed by the States and Government to investigate and determine important questions upon the basis of exact knowledge is a pertinent illustration. The Wisconsin Commission is settling all matters concerning the public utilities solely after adequate investigation and skilled tests. These same matters can never again become the football of partisanship or political manipulation. Likewise, the commission form of municipal government is removing from the field of politics, and local contention, questions which are really largely matters of skill and exact science. The best kind of water supply, the proper sort of sewage disposal, the best way to handle streets, street railways, public parks, schools, playgrounds, public health, the housing problem, etc., are no longer matters of fight or ballot in well-ordered communities. There exists always a best way, and experts are selected to find and direct it. The modern civilized community is no longer a state, but a school. The body politic has become one vast, complexly organized, research institution. Governments are, in this age of industrialism, instruments for replacing darkness with light, for substituting for the indefinite and approximate, the definite and accurate. This is about all there is to the best public service. The State has become a great thinking, investigating organization, or laboratory, or research institution. There is this distinction between the school and the State: the school researches only, the State researches and acts. The illumination of great public matters by modern scholarship is best illustrated by what is constantly occurring in the countries of western Europe There, as every one knows, municipalities are in the hands of experts whose life work is a study, as in a laboratory, of the needs of the community and its individuals. Nothing is left to chance, and little to choice, except when the people can be trusted to choose wisely. The city and State with its utilities, sanitary inspection, land purchase, construction and sale of homes for working men, control of food, care of children, supply of milk, expert advice to mothers, the promotion of all sorts of special schools, museums, galleries, theatres, concert halls, municipal banks, pawnshops, employment bureaus, industrial insurance, old-age pensions, etc., etc., is conducting a laboratory for racial and civic betterment, and is carrying upon the broad shoulders of the State the burden that a democracy would shift to the people themselves. All new or difficult questions receive special study, and an honest attempt is made to settle them in the best manner.

SEWAGE DISPOSAL AND THE GREAT LAKES.

The International Joint Commission on Waterways is now in session at Ottawa, and is taking evidence preparatory to reporting on the question of the pollution of boundary waters. It will be remembered that a short time ago this Commission was instructed by the governments of Canada and the United States to investigate and report on this question.

Dr. McLaughlin, of the Surgeon-General's Office at Washington, D.C., in his evidence before the Commission last week, stated that to compel cities along the Great Lakes to so treat their sewage that it would not contaminate the lakes into which it is dumped would place upon these cities an unnecessary and unjustifiable expense which would bankrupt the cities in most cases. He adds that it is largely a matter of sentiment which would prohibit dumping raw sewage into rivers and lakes. He considered it impossible that contamination from Canadian cities was ever washed across the lakes to make impure the water of an American city, or vice versa.

Dr. Hastings, Medical Health Officer of Toronto, takes issue very strongly with Dr. McLaughlin, and his objections are well taken. Dr. Hastings, however, labors under a misapprehension when he states that Dr. McLaughlin's viewpoint, as expressed in his evidence, is that of the engineer rather than the health officer. It is true that the engineer is controlled to some extent from the standpoint of economy, and is not governed by the desire for complete bacterial purification. Dr. McLaughlin cannot be considered in any sense an engineer, and we are quite satisfied that if engineering experts had been consulted their evidence would have been very different from his.

If Dr. McLaughlin has been correctly quoted, his evidence is certainly not borne out by the facts. It is well known that Niagara Falls, for many years, has had the highest death rate due to typhoid of any city or town in America, and this has been directly due to Buffalo dumping its untreated sewage into the Niagara River above Niagara Falls. The provincial bacteriologist for Ontario in his report for last year states that a study of Lake Ontario water would lead one to suspect that this lake is becoming more and more infected. The samples collected some years ago would have led one to hope that it was possible to go out into the lake far enough to escape shore infection, but this year he has found infected samples and those containing high bacterial counts fifteen miles out into the lake. The chemical samples collected at the same time bore out these findings. He states that though infection is less frequent far out, still it exists, and comparatively frequently.

It is understood that the provincial health authorities of Ontario will be represented before the International Joint Commission before the investigation is completed, and it is altogether probable that their evidence will be decidedly against that offered by Dr. McLaughlin.

EDITORIAL COMMENT.

It is nearly time the city of Toronto took action on the question of a City Architect. We are tempted to believe that another of the Council desires a permanent civic position.

* * * *

The council of the city of Winnipeg, as is usual with such bodies, before acting on the report on a new water supply, is first wasting valuable time in criticism of the expert who made the report. What should be done at the earliest possible moment is to secure an accurate estimate of the cost of obtaining water from Shoal Lake.

* * * *

The raising of the standard of entrance to the University of Toronto this session has had its effect on attendance. Last year's registration in the first year of the Faculty of Applied Science and Engineering was about two hundred and eighty. This year's registration is, to date, one hundred and eighteen.

* * * *

Hon. Frank Cochrane, Minister of Railways, at a railway route map hearing, held in Ottawa recently, withheld his approval of the route of the Alberta, Peace River and Eastern Railway until October 15th, in order to give the promoters an opportunity to prepare a map of the Calgary-Edmonton section, giving more details and indicating more clearly the location of the other railway lines. Incidentally, he stated that in future he does not propose to approve railway lines until good surveys have been made. We are glad to note this move of the Minister. Far too many projected railroads have received their charters without sufficient preliminary surveys being made to show the practicability of the individual schemes.

* * * *

Last week we emphasized the remarks of Sir William Willcocks before the Western Canada Irrigation Association, concerning the tendency towards light design in the irrigation works of Western Canada. In the daily press this week we note that the intake belonging to one of the irrigation companies has failed. The structure is almost completely destroyed, and it is understood that there was the loss of one life. There is little question that in many instances economy of design rules to the exclusion of a proper factor of safety. The regulating works on the rivers in the East are most conservatively designed and built; in fact, to the minds of those in the West, accustomed to making a dollar go as far as it will, these works appear stronger than there is any necessity for. At the same time, practically no failures occur there. As population increases in Western Canada, the necessity for more permanent works will become apparent.

DEATHS IN FACTORIES.

According to the report of the chief inspector of factories of Ontario for the year ending December 31, 1911, there were 985 accidents reported during the year, which is an increase over the previous year. One reason for the increase is that minor accidents are now reported and another is that the law regarding the reporting of accidents is better observed than formerly. The chief inspector states that a large percentage of the accidents were due to causes that could not reasonably be foreseen and could only be avoided by the exercise of care on the part of the employees themselves. The fatal accidents totalled 44, which was proportionately the same number as in 1910.

CANADIAN PORTS OF THE PACIFIC.

The Panama Canal is now so nearly an accomplished fact that the importance of the Canadian ports on the Pacific is becoming greater than ever. In a paper prepared for presentation to the annual convention of the American Society of Civil Engineers to be held at Seattle, Wash., on November 20th, 1912, Mr. H. M. Chittenden has discussed the larger ports of the Pacific Coast under the headings of Strategic Relations of Coast Ports, Descriptive Data, Engineering Problems, Administrative Systems, Plans for the Future, Influence of the Panama Canal. As the paper is a very comprehensive one and rather long, we present a very brief abstract of that portion which deals with the Canadian ports.

Commerce of the Pacific.—Since the days of Magellan, imaginative minds have pictured the Pacific Ocean as the future home of the world's commerce. There is something in the immensity of that ocean, in the present vastness of the population on one shore and the future vastness of that on the other, which conjures up visions of argosies such as the Mediterranean or the Atlantic has never known. The situation as it actually exists, however, makes this picture somewhat of an illusion. The very wideness of the intervening sea is a mighty barrier to economic intercourse across it. The breadth of the Pacific as compared with that of the Atlantic, depending on the latitude, is as two or three to one; and, while the cost of transit and loss of time may not be in the same proportion, there is still a wide disparity against the larger ocean. There are also the almost insuperable barriers of race and economic conditions on the Asiatic Coast. We do not admit the Oriental to our shores as we do the European. That immense source of traffic which has sustained its thousands of ships on the Atlantic is cut off on the Pacific. Likewise those Oriental countries have little to offer the traveller, which can compare with the lure of European civilization, ancient and modern. Tourist traffic across the Pacific is a bagatelle compared to that over the Atlantic. Finally, the deep poverty of the hordes who swarm the Asiatic shores, and the backward condition of industry there, are not promotive of vigorous commercial intercourse, for they offer relatively little to sell and less with which to buy.

Thus it results that the commerce of this ocean, great though it be, is small compared with that of the Atlantic, and small to what might be expected from the millions of inhabitants affected by it. Its growth in the near future, strange as it may appear, is more dependent on the countries which border the Atlantic than on those washed by its own waters. As far as the Pacific Coast is concerned, the eyes of its people are turned east rather than west. It is there that their kindred dwell; it is there that the capital exists which shall develop their boundless resources; it is thence that must come those who shall help to populate their shores. It is this fact—that their future is on the Atlantic rather than on the Pacific—which makes the opening of the Panama Canal an event of such tremendous import to them. It is bringing them to their own. It fronts them toward Europe. It opens to them the treasures of the Occident—far more potent, if less romantic, than those of the Orient. It gives them something of the advantage which the eastern shore of the Continent enjoys by reason of its closer relation to the fundamental sources of our civilization.

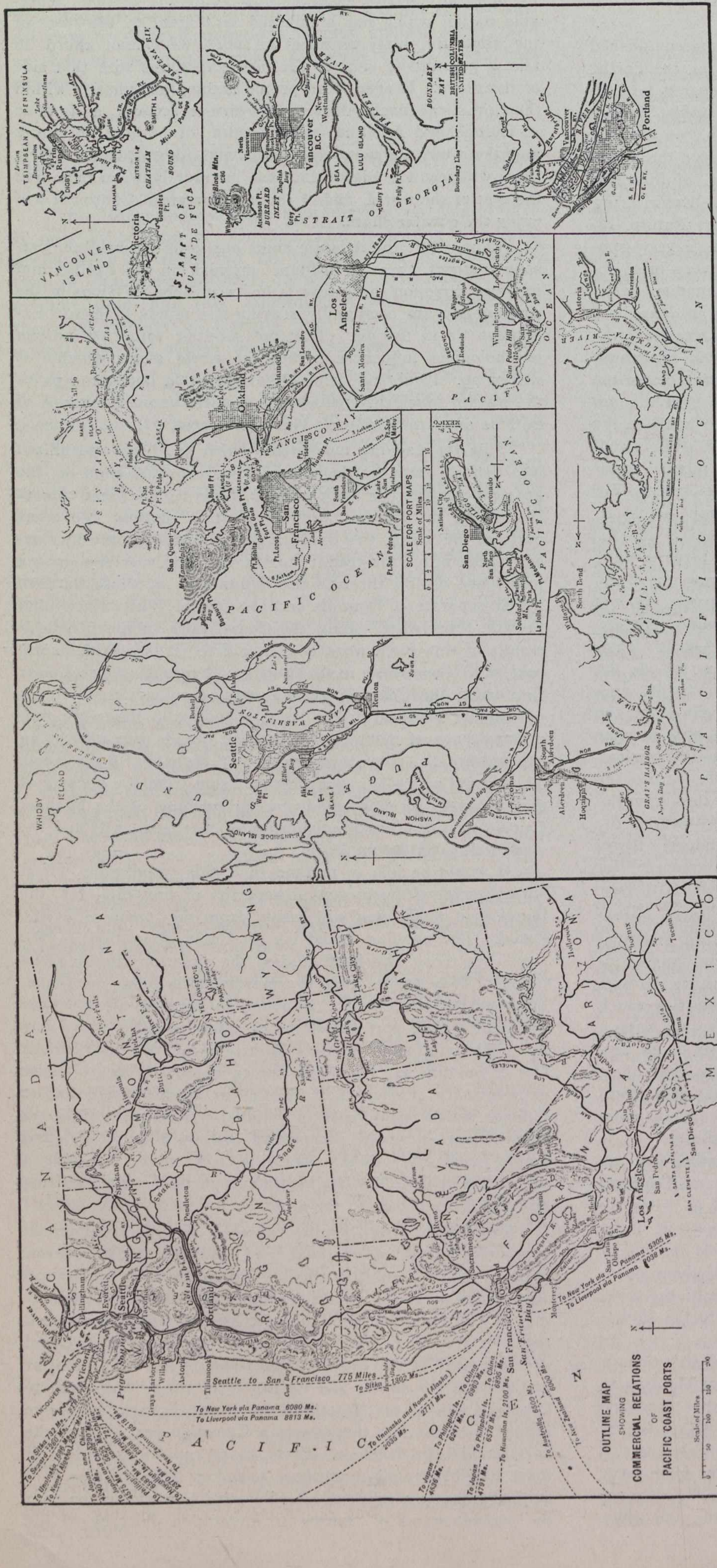
If this condition is true of the present, and will remain so, to a degree, for the indefinite future, let it not blind us to the profound changes which are taking place in those ancient, and, but yesterday, non-progressive, countries which lie on the other side of the Pacific. When we consider what a volume of commerce the accidents of political fortune have turned in this direction from the distant Philippines; when we reflect on the marvellous progress of modern Japan; and when we note the amazing changes now going on in that venerable nation which has slumbered indifferent to the rest of the world for thirty centuries or more, we cannot afford to take a pessimistic view of our future relations with that side of the globe. If ever these people accomplish what is within their practical reach; if ever they turn to account, as is done in Europe and America, their wealth of natural resources and their own capacity for industrial development, surely there will result a mighty increase in trade between them and the rest of the world, and of this the American Continent will enjoy the greater share.

Thus, while the Atlantic holds out to us the brighter present prospect, there is brilliant promise in the Pacific, and in every direction the future is big with hope. Visions of the coming day are profoundly stirring the minds of men. Expansion is in the air. The measureless force of unseen psychological influences rushes the world along whether it will or no. Doubtless, it builds exaggerated hopes and paves the way to much disappointment, but its very exuberance of faith is an earnest of vast accomplishment.

This far-reaching movement, which has been crystallized into definite form by the approaching consummation of the greatest engineering work of ages, finds its intensest expression along the Pacific Coast of North America. To other parts of the world, the Panama Canal means simply increased opportunities for trade; to the Pacific Coast it means a new lease of life through the elimination of those barriers which separate it from its true source of sustenance and growth. Everywhere along the Coast, faith in the beneficial results of this great work is unbounded. It is a faith, moreover, which expresses itself in works. From Alaska to Lower California, the Coast is getting ready for the Canal. It is putting its house in order. It is spending in this work prodigious sums of money. The present decade will witness an expenditure in port development of probably $50,000,000. The slogan which has won this vast sum from the pockets of the taxpayers is: "Get ready for the opening of the Panama Canal," and the formal celebration of that event will find the work well toward completion.

It would be idle to pretend that this prodigious effort springs solely from an actual necessity of providing for the increase of traffic that will result from the opening of the Canal. The popular belief is, of course, that this is the case; but those who have studied the situation closely know better. They realize that the movement is being overdone, but they recognize that it is bound to keep on through the fear which each port entertains of what its sister ports may do. The stigma of possible failure in the race and fear of loss of prestige are the potent forces which are back of these extraordinary efforts. Los Angeles or Seattle would find it difficult on the cold basis of rational business foresight to justify their enormous prospective outlays; but they find ample justification in the necessity of keeping up with a procession which now stalks with tremendous strides from one end of the Coast to the other.

Vancouver, B.C.—Seattle's greatest rival for commercial supremacy north of Portland and Tacoma is Vancouver, B.C., a rival whose strength lies not so much in its natural advantages as in the artificial conditions arising from its being in a different national jurisdiction. It has a good strategic location, it is true, being at the outlet of the second greatest river of the Pacific Coast; but its harbor is inferior to those farther south, and its rail connections east, even to Central Canada, are inferior. Its early growth was due primarily to the fact that it was a Canadian port. That the port would have developed where, or as rapidly as, it has, if there had been no international boundary near by may well be doubted. As conditions actually exist, however, taken with the present status of American navigation laws by which



cheaper foreign shipping is excluded from our coastwise trade, Vancouver is a formidable competitor with ports farther south. In the fish and lumber export trade, particularly, conditions tell heavily in her favor.

Prince Rupert.—Prince Rupert is the northernmost Pacific terminus of the transcontinental lines and will remain so until some line shall cross into the valley of the Yukon and descend that mighty river on its way to the westernmost apex of the Continent. It is 40 miles south of the international boundary of Alaska (54° 40′) and about 700 miles along the coast from Seattle and that much nearer Alaska. It is the westernmost, as well as the northernmost, transcontinental terminus, and is 500 miles (according to the statement of the Grand Trunk Pacific officials) nearer Asia than any other terminus on the Pacific. It is said that a traveller from China would be able to reach Winnipeg, via Prince Rupert, before he could reach Vancouver, if he were to go by that port. Add to this the fact that the gradient over the mountains, with the exception of about 20 miles of 1% on the west slope, is everywhere under five-tenths, and most of the way much less than this, and some of the physical advantages of the route are apparent. Add again the proximity of Prince Rupert to the limitless wheat fields of Canada, the fact that it is in the very centre of the salmon and whale industry, among inestimable quantities of virgin timber, and its great future seems doubly assured.

Its advantages are offset to some extent by the severity of northern winters, but chiefly by the different nationality of the territory (Alaska) which it is best fitted to serve.

Secondary Ports.—Somewhat outside the rivalries of the great ports along the Coast, and flourishing on advantages which are peculiar to themselves, are several smaller ports. Among them, and the more prominent, are San Luis Obispo, about half way between San Francisco and Los Angeles; Humboldt Bay, on the North California Coast; Coos Bay, 200 miles south of the Columbia and serving an important section of Western Oregon; Astoria, just inside the Columbia Bar and the first port to be established on the North Pacific Coast; Grays Harbor, a great lumber port on the west coast of Washington, 45 miles north of the Columbia; and Victoria, an important harbor and naval base on Vancouver Island. There are numerous harbors on the Alaskan coast, but they are still in a state of Nature, as very little has been done toward converting them into up-to-date ports. The prospective opening of the coal fields of Alaska, and a more definite Alaskan policy on the part of the Government, will undoubtedly lead to the establishment of permanent facilities at some of these points in the near future.

In its physical characteristics the Pacific Coast line of North America increases in severity from south to north, but there is less diversity in climatic conditions than one might expect for such great differences in latitude, owing to the moderating effect of the ocean currents. It is not until well up on the Alaskan Coast than one finds the harbors regularly sealed by ice in the winter season. Storms are more severe in the northern latitudes, but this is more than offset, as far as coastwise trade is concerned, by the sheltered inland passages which extend for at least 1,000 miles from Southern Puget Sound north. The tidal fluctuation increases from south to north from a mean of about 4 ft. at San Diego to 14 ft. at Prince Rupert. The teredo is very destructive in all the waters of the Coast, but the limnoria is active only in Californian waters. Nearly all the tributary streams are heavy silt carriers, and the primeval bays and inlets are partly or wholly filled up, making dredging a necessary adjunct of harbor development all along the Coast, and necessitating costly training dikes to scour channels across bars or shoals. In Southern California, the immediate shores were originally lightly timbered; but from Northern California north they were covered with magnificent forests. The coast line is remarkably uniform and unbroken by indentations as far as the Strait of Juan de Fuca, but from there north the exact opposite is the case.

Vancouver, B.C.—The chief Canadian port, Vancouver, B.C., is in the vicinity of the mouth of the Great Fraser River, though actually not in the valley of that stream. More fortunate than Portland, Vancouver has been able to flank a troublesome river with its floods and shoals while still taking advantage of its valley on its rail route through the mountains. The port has been built in a land-locked bay called Burrard Inlet, surrounded on nearly all sides by towering hills which give the location a most beautiful setting. The area of the entire inlet inside the entrance is 23.6 miles, with a shore line of upward of 50 miles; but the port proper, as at present developed, utilizes only a small fraction of this. The shores are mainly of rock formation; the tidal range is 11 ft. mean and 16.4 ft. extreme. There is no ice and the harbor is perfectly sheltered and has good anchorage.

The port facilities, as developed so far, are mainly on the south side of the east 5.5 miles of the Inlet. The portion of the Inlet comprising the harbor is about 1⅓ miles in width, connecting with the Gulf of Georgia on the west and the remainder of the Inlet on the east by two narrow channels designated First and Second Narrows, respectively. These Narrows were formed by the deposit of gravel, sand, and small boulders brought down by mountain streams on the north side of the Inlet and deposited in the shape of extensive bars. The narrows are deep, but only about 500 ft. in width. Navigation through them is seriously handicapped by strong tidal currents, which, at the First Narrows, reach as high as 8 knots per hour at spring tide, and are such a menace to navigation that the Dominion Government has undertaken to widen the entrance by dredging to 1,200 ft. The improvement will not affect the current perceptibly, but will give more leeway for the navigation of ships. In most portions of the harbor the tidal currents interfere seriously with the berthing of ships.

New Westminster.—Ten miles south of Vancouver on the Fraser River, and 16 miles above its mouth, is the town of New Westminster, which is taking active steps to develop port facilities for deep-sea shipping. The Fraser is a large river, not unlike the Columbia, but with a channel less difficult to improve and maintain. The ordinary tidal range at the port is only 5 ft., but the range between high and low water in the river is 14 ft. Reference will be made in another place to the steps being taken to develop this port.

Victoria.—This has been an important port in the past, and is so still, though its commercial business is not large. It is the chief port of Vancouver Island and on it is located the capital of British Columbia. The commercial port is on a small land-locked inlet with bald rocky shores. A few miles to the west is the celebrated Esquimault, an excellent port, strongly defended, and, prior to 1905, the headquarters of the British North Pacific Naval Squadron.

Prince Rupert.—This harbor is on an island within a well-sheltered inlet on the "inside passage" to Alaska, a little north of the mouth of Skeena River, the valley of which stream is the route of the western division of the railroad. The area of the entire inlet in front of and back of the island is about 27 sq. miles, and that of the shore line is about 80 miles. The tidal range is large, the maximum being 27 ft. and the mean about 14. The harbor is perfectly sheltered and is free from ice.

The port is very new, and its development has only begun. It now has about 2,700 ft. of berthing space, of which 600 ft. belongs to the Provincial Government and the rest to the Grand Trunk Pacific. It has a sectional dry dock 600 ft. long. The newness of the port and the fact that rail connection east is not yet opened, give little as yet for comparison with other ports. Its record lies all in the future.

The promoters of this important terminal enterprise adopted the almost unique course in civic growth of laying out their city before its occupancy by settlers began. It has been scientifically planned by artists of national reputation, and, if the plans are followed, it will be spared the disfiguration characteristic of most American cities.

The development of the ports of the Pacific has evolved a great range of engineering problems, some of which are of unusual magnitude, difficulty, and cost.

The subaqueous basaltic rock excavation at the eastern end of Victoria Harbor was performed by the drilling method. The single drill was mounted on a platform float that could be raised clear of high tide by steam power spuds. Steam was furnished from boilers on a barge. Thirty-two holes were drilled at one setting of the raised platform. The holes were 2.5 in. in diameter, drilled to a depth of 2.5 ft. below grade (20 ft. at low water), and spaced 3 by 3 ft. The actual cost for drilling and blasting only was $6.17 per cu. yd., without interest, depreciation, or plant renewal.

The blasting in Vancouver Harbor will be a more delicate operation, as it will be carried on in close proximity to constructed piers. Holes 3 in. in diameter, spaced 5 by 5½ ft. centres, will be drilled to a depth of 3 ft. below the required grade line (36 ft. at low tide), and shot off in series. It is expected that 1½ lb. of dynamite per foot or more will be used. The estimated cost for drilling and blasting is $5.60 per cu. yd. Dredging of the broken rock will approximate an additional $1 per cu. yd. The Vancouver rock is a sloping sandstone ledge overlaid with from 3 to 7 ft. of gravel, hardpan, and disintegrated sand rock.

Probably the most effective dredging plant for all purposes on the Pacific Coast is the Frühling, built in Germany in 1906 at a cost of $275,000 exclusive of duty and cost of steaming to British Columbia. It is the property of the Department of Public Works of Canada, and operates on the Fraser River. It is of the "Frühling" scraper suction type, elevating material by a pair of 16-in. centrifugal pumps through pipes and delivering to hoppers inside the hull. It is a sea-going dredge, of steel construction throughout, and is self-propelled by twin screws. Its length between perpendiculars is 187 ft.; the extreme beam is 34.5 ft., the draft loaded, about 14 ft., and the hopper capacity at this draft

800 cu. yd. Its performance from April 1st, 1910, to March 31st, 1911, was as follows:

Hours worked	862.5
Cubic yards excavated	924,800
Average cubic yards per hour	1,072
Average cubic yards per day of 9 hours, including all delays	3,000
Maintenance cost	$37,948.10
Repairs cost	8,835.58
Total cost	46,783.68
Cost per cubic yard	$0.0505

The Grand Trunk Pacific dock at the foot of Madison Street, Seattle, is a recent structure. It is 625 ft. long, 128 ft. wide, and is supported entirely on creosoted piles, the length of the bearing piles varying from 55 to 90 ft., with bracing piles as long as 110 ft. The bents are 10 ft. apart, and the piles in the bents are spaced from 6 ft. centres at the inner end to 3 ft. at the centre. The capping and floor systems are of very thorough construction, and the dock appears to have thorough stability, notwithstanding the great depth of water in which it stands.

The main shed is 90 ft. wide, with a platform 8 ft. wide on the south side and 16 ft. on the north, the latter carrying a railroad track. There are five adjustable slips on each side and one at the outer end worked by worm gear. The fender piles are of tight-bark fir and are driven two at every bent and fastened to 12 by 12-in. stringers with ¾-in. straps. At the outer end they are spaced 3 ft. apart, and clusters of seven piles are driven at the outer corners. The timber used in construction was 241,775 lin. ft. of creosoted piling, 71,000 ft. B.M. of creosoted bracing, and 1,113,000 ft. B.M. of other lumber. In its finish, offices, equipment, and general lay-out, it is the best example of dock construction on Puget Sound.

The second of the docks selected for a brief description here is the Great Northern dock at Vancouver, B.C. It was designed by A. W. Münster, M. Am. Soc. C.E. The pier is 450 ft. long by 293 ft. wide, with a berthing space of 30-ft. depth at low water on each side, and with two sheds, 403 by 102 ft. Between the buildings is a space 41 ft. wide. The distinctive feature of the structure is a cantilever platform supported on cylindrical concrete piers, which themselves rest on a sandstone ledge. These piers are 4.5 ft. in diameter, with a base enlarged to 10 ft. The foundation is carried down into the hardpan or sandstone ledge to a minimum depth of 3 ft. below the bottom of the slip. The piers will have an average height of 52 ft. On top of them will be placed a longitudinal concrete girder, 3 ft. wide and about 7 ft. in depth, which will carry the transverse girders forming the immediate support of the floor slab, which are placed 12.5 ft. centre to centre. The transverse girders are from 2 to 3 ft. wide, 6 ft. deep, and 51 ft. long. They will project 16.5 ft. beyond the line of the piers and, acting as a cantilever, will carry corresponding parts of the front platform. The inner end of these girders will rest on a line of 16-in. concrete piles driven to refusal and stayed in position before the rock embankment is placed. The floor slab is to be 7 in. thick. The concrete platform and beams have been designed for a distributed load of 500 lb. per sq. ft. The railroad track running the length of the platform is placed centrally over the longitudinal girders. The reinforced concrete construction supporting the track is proportioned to carry a 100-ton switch engine. Tie-rods encased in concrete will anchor the concrete platform firmly to the embankment.

The warehouse buildings are of wooden construction covered with galvanized iron. The roof is to be carried on

Comparative Costs to Ship and Cargo in Pacific Coast Ports.

	San Diego.		Los Angeles.		San Francisco.		Portland.		Puget Sound.		Vancouver, B. C.	
	Rate.	Amt.	Rate.	Amt.	Rate.	Amt.	Rate.	Amt.	Rate.	Amt.	Rate.	Amt.
Pilotage (in)	$3 per ft. draft ...... 3 cents per ton	$270	$1 per ft. draft ...... 1 cent per ton	$90	$3 per ft. draft ...... 3 cents per ton	$270.00	$4.50 per ft. draft .... 3 cents per ton	$315	$125 to $175......	$150	$1 per ft. draft ...... 1 cent per ton	$90
Water, survey and misc. (estimated).....	....	50	....	50	....	50.00	....	50	....	50	....	50
Dockage, per day..........	$2 plus ⅜ cent for each ton over 200....	285	For ship over 1 200 tons.. $14.75	177	Discharging: $4 plus ¾c. for each ton over 200. Loading: ⅛ of above...	427.50	None	0	None	0	None	0
Stevedoring, per ton......	40 cents........	9 600	40 cents..........	9 600	40 cents..........	9 600.00	40 cents........	9 600	40 cents..........	9 600	40 cents..........	9 600
Handling, per ton	Included in "wharfage."	......	41.8 cents (av.)..	10 032	25 cents..........	6 000.00	Included in "wharfage."	......	Included in "wharfage".	......	Included in "wharfage."	.....
Dock rental. per linear ft. per month...	0	....	0	....	45 cents..........	225.00	....	....	0	....	0	....
Wharfage, per linear ft. per month	50 cents........	12 000	6½ cents (av.)...	1 560	5 cents (24 hrs.)..	1 200.00	50 cents........	12 000	50 cents (120 hrs.)	12 000	50 cents..........	12 000
Wharf storage, per linear ft. per month...	....	....	....	....	5 cents (48 hrs.)..	....	....	....	25 cents per ton per mo. or frac. mo.	0	....	....
Pilotage (out).	Same as "in"...	270	Same as "in"...	90	Same as "in"....	270.00	Same as "in".	315	Included in charge for "in" pilotage..........	0	Same as "in"	90
	....	$22 475	....	$21 599	....	$18 042.50	....	$22 280	....	$21 800	....	$21 830
Cost paid by ship..........	....	$875	... .	$407	. ...	$1 242.00	....	$ 680	....	$200	....	$230
Cost paid by cargo........	....	21 600	....	21 192	....	16 800.50	....	21 600	....	21 600	....	21 600

This table is the result of a comparative study of the rates in the different ports with a view of determining the relative tax on commerce in each. In order to arrive at a condensed approximation of the cost of terminal charges and a comparison of the principal Pacific Coast ports, a purely hypothetic case has been assumed of a 6 000 net ton register ship, 30-ft. draft, discharging and loading cargoes of 12 000 tons of miscellaneous freight, the ship remaining in port 12 days. It is admitted that the assumption is not typical of ordinary occurrences, but it is apparent that, because of the complex and diversified tariffs, as well as lack of uniformity in freight staples, it is well-nigh impossible to obtain averages except through an assumption that is somewhat strained. The cost of stevedoring has been taken at the uniform rate of 40 cents per short ton at all the ports. This is not strictly true, but the labor unions may be relied on to equalize the cost by dictating the labor wage and the length of a day's work. Small miscellaneous items like water, etc., are insignificant, and have been lumped in the table at $50 per voyage. The charge for handling is a variable sum. The attempt has been made to arrive at an equitable average for each port. The dock rental, in San Francisco, for lines having regular assignment, is 45 cents per month per linear foot of dock rental. A 500-ft. space will amount to $225 per month. A monthly sailing for the case docketer will make the rental $225 per voyage.

trusses spanning the whole width of the building, leaving an unobstructed floor space. The floor inside of the building will be paved with creosoted blocks on a concrete base. The concrete slabs on the outside platform are to be covered with an asphalt wearing surface. The cost of the completed dock and buildings will be approximately $1.50 per sq. ft.

British Columbian Ports.—The British Columbian ports, particularly Vancouver, are wholly private-ownership ports, and the water-front development is almost exclusively in the hands of the railroads. It is a striking contrast to the great Canadian port of Montreal, which is one of the most progressive public-ownership ports in the world. Vancouver is passing through the boom experience of most new localities in the West, and is willing to make almost any concession to private interests for what promises most for the immediate present. Not until after the present period of expansion has passed, and public thought, now absorbed in speculation activities, has time to take stock of the situation, is it likely that the problems of port control will be given very serious consideration.

The British Columbian ports being still almost exclusively under railroad control and ownership, as far as port facilities are concerned, the rates are privately controlled, and the charges are absorbed largely by the railroads.

Vancouver, B.C.—As already stated, no comprehensive scheme of development of this port has been adopted. Special studies have been and are being made of different parts of the harbor, and there are rumors of gigantic development plans by private interests. The Great Northern Railway has a fine new pier under construction and other private improvements are in progress; but there is as yet no general plan, no distinctive scheme of port administration, and no provision of public funds.

The conformation of the harbor and the handicap of tidal fluctuation and currents have suggested an improvement which, though costly, would seem to possess great merit. That is to place a lock and dam across the throat of the harbor at the second Narrows, thus holding the upper part of the Inlet at high tide and making it a fixed-level fresh-water harbor. This would restrict the tidal area to one-third its present extent and would reduce tidal currents in the lower harbor so much as greatly to improve conditions there. It would seem on the face of it that this would be an improvement of great importance to the future of the port.

New Westminster.—The fresh-water port of New Westminster is taking active steps in harbor development. It has recently expended $15,000 on the study of a plan and its presentation and is about to put into effect the one prepared for it by A. O. Powell, M. Am. Soc. C.E. It comprises wide, marginal streets, routes for railways, the extension of the city quay, and a long waterway in a slough parallel to the river, from which the river is to be excluded at the upper end. A succession of parallel slips, oblique to the axis of the waterway, will develop a berthing space of 7½ miles.

Victoria.—Even that sometime staid and delightful provincial town of Victoria, more distinctly British than any other port of the Pacific, has become infected with the Panama bacillus and is cogitating what it may do to be prepared for the changes which it has been told are about to ensue. No definite plans have as yet been evolved, but among the tentative suggestions are an outer harbor to be protected by a breakwater in front of the present entrance to the inner harbor; and also a development in Oak Bay on the opposite side of town fronting to the eastward.

Prince Rupert.—Studies for the port of Prince Rupert are now in progress under the direction of Mr. Bogue, but are not yet far enough along for incorporation in this paper. A suggestion that has been made of possible future development in this port, however, may be properly mentioned. Prince Rupert City is on an elliptically shaped island about 6 miles long north to south by 4 miles east and west. The "lakes" which separate the island from the mainland in the rear have an area north of the railroad crossing of about 40 sq. miles. It is not unlikely that the north and south passages will be dammed off and provided with locks, thus converting the lakes into a tideless, fresh-water harbor just at the level of high-tide. While this development is still some distance off, it has such great advantages, in view of the extreme tidal fluctuation in Prince Rupert harbor, that it will probably be realized eventually.

BRIQUETTING BITUMINOUS COAL

In the modern methods of mining bituminous coal large quantities of slack are produced; and while in some sections of the country there is a market for the slack, for use in industrial plants provided with mechanical stokers, in other sections there is little or no market for it, states "Conservation." For this reason a number of the operators in Nova Scotia are considering the installation of briquetting plants for the purpose of converting this slack into a higher grade and more suitable fuel.

On account of the friable nature of the coal mined at the MacKay Mine much slack is made during mining operations. As there is little or no market for this slack coal the management installed a briquetting plant with a capacity of 10 tons of briquettes per hour.

This is the first plant to be installed in Canada for the purpose of briquetting bituminous coal. Unfortunately, it was damaged by fire during the month of July.

The same company are also installing two similar units at the Colonial Mine, which are expected to be in operation this year.

The briquetting plants are of Belgian manufacture and are of the roll press type.

The following is a short description of the MacKay briquetting plant:

The coal from the mine is screened over a ¾ inch screen; the lump coal (over ¾ inches) is sent to the market, and the fine coal is carried by a disc elevator to a 75 ton bin. The coal is discharged from the bin by chute into a 10 ton concrete pocket situated at the briquetting plant. The coal is then elevated by a bucket elevator to a 3 ton cone hopper. The coal is fed from the hopper to the disintegrator at any desired rate of speed by means of a revolving table and plough-shaped cutter situated at the bottom of the hopper.

The pitch after being crushed is fed into the disintegrator by means of a similar adjustable feed. From the disintegrator the coal and pitch is elevated to the mixer where superheated steam is added. The heated coal is then conveyed to the roll press by means of a spiral conveyer. The briquettes are usually soft as they come from the rolls but upon becoming slightly cool they become hard and withstand handling very well.

The pitch used as a binder for the briquettes varies from 6 to 8 per cent. of the weight of the coal. This pitch is one of the by-products obtained from the tar recovered at the Dominion Iron and Steel Company's oven plants.

The briquettes are ovoid in shape and have been used with considerable success upon the Intercolonial Railway and for domestic purposes.

The Inverness Railway and Coal Company are also installing a briquetting plant at Inverness, C.B., for the purpose of briquetting the slack made during mining operations.

Briquettes when properly made with a suitable binder possess the several advantages over raw fuel.

RAILROAD EARNINGS.

The following are the railroad earnings for the week ended September 14th:—

	1911.	1912.	Increase or decrease.
C.P.R.	$2,325,000	$2,667,000	+ $342,000
G.T.R.	1,026,449	1,110,000	+ 84,065
C.N.R.	378,300	360,300	+ 18,000
T. & N.O.R.	39,366	28,573	— 10,793

New records in both gross and net earnings are shown in the C.P.R. statement for the month of August, issued on Saturday. Gross exceeded by about $200,000 the gross in July, when earnings for the first time passed the $12,000,000-mark. Net profits were $36,800 ahead of net in October of last year, the previous record month for the company in this respect. The gain in net in August as compared with the same month last year was $642,354, or nearly 16 per cent. The statement for the month follows:—

	August, 1912.	July 1 to August 31, 1912.
Gross earnings	$12,251,715.87	$24,304,114.45
Working expenses	7,553,790.21	15,138,011.89
Net profits	$4,717,925.66	$9,166,102.56

In August, 1911, the net profits were $4,075,571.01, and from July 1st to August 31st, 1911, there was a net profit of $7,773,599.34. The gain in net profits for the same period last year is, therefore, for August, $642,354.65; and from July 1st to August 31st, $1,387,503.22.

A cable to The Montreal Star says:—"The Grand Trunk August statement shows that the net profits for the Grand Trunk increased £35,200 sterling. Canada Atlantic showed a net decrease of £2,550. Grand Trunk Western, net increase of £6,850. Grand Haven, net decrease of £1,950.

The total profit for the whole system increased £37,550, which is regarded by the market as a fine showing.

PANAMA CONSTRUCTION ESTIMATES

In thirteen months a vessel will go from the Atlantic to the Pacific Ocean through the Panama Canal, according to new, revised estimates recently made public by the Panama Canal Commission. October 15th, 1913, is the tentative date set for the passage of the first boat through the canal. The "christening" will be done by a naval vessel. President Taft has been advised of the latest estimates of Colonel Goethals, in charge of canal construction work. The President's approval of the new canal opening programme is awaited. Formal opening of the canal will occur January 1st, 1915, it is announced. Commercial vessels will be given its unrestricted use in December, 1913.

That the canal will be completed far below the estimated cost of $400,000,000 is reported by Colonel Goethals. It will run as low as $375,000,000. About another million dollars will be saved, it is declared, in interest charges.

The total amount of excavation work to September 15th is about 242,134,000 yards. A recent increase of over 16,000,000 yards in the estimates was caused by big slides in the Obispo division. The amount of excavation completed to September 15th was 218,000,000 yards, leaving approximately 24,000,000 yards to be dug. The average rate of excavation a month is now about 2,500,000 yards, a conservative estimate. At the present rate of progress all the digging should be finished before September 1st, 1913.

The big dam, locks and spillways projects show stages of completion varying from 75 to 90 per cent. It is estimated that the Gatun locks will require about 2,000,000 cubic yards of concrete work. To September 15th well over 19,000,000 cubic yards has been put into place. The concrete work of the Pedro Miguel locks is nearly 95 per cent. completed, and that of the Miraflores locks over 92 per cent. The Gatun spillway will probably be completed within another month. Other engineering features show an equally advanced stage toward completion.

The canal will have a summit elevation of 85 feet above sea level, to be reached by a flight of three locks located at Gatun, on the Atlantic side, and one lock at Pedro Miguel and a flight of two at Mira Flores, on the Pacific side. Each lock will have a usable length of 1,000 feet, and a width of 110 feet, which will be the minimum width of the canal.

The canal is to be about 50 miles long from deep water in the Caribbean Sea to deep water in the Pacific Ocean. The channel will vary in width from 1,000 at a point just south of the Gatun locks, to 30 feet at a point near the Pedro Miguel lock. There will be a number of places where several boats can pass abreast of each other and the minimum depth will be 41 feet.

LARGE TURBINES FOR RIO DE JANEIRO.

After having supplied, in 1908 and 1909, six units, each of 9,000 horsepower, for the Rio de Janeiro Tramway, Light and Power Company and their power station at Pirahy, Messrs. Escher Wyss and Co., of Zürich, are installing two more turbines, each of 20,000 horsepower, so that the works will altogether have available nearly 100,000 horsepower. The firm has supplied the turbines (Pelton wheels) as well as the pipe system. The turbines are provided with vertical shafts, which are suspended, the wheels being at the lower ends. The nozzles, of which there are four to each wheel, are controlled quite independently of one another by levers from a servo-motor. Two discharge-ports are provided in the wheel-casings in case of accident. A sluice-valve is also arranged on the supply main; this valve and the outlets are operated by the pressure regulator. These measures are very necessary, since the turbines work under a head of 286 m. (940 ft. nearly), and, running at 300 revolutions per minute, consume about 6.2 cu. m. (219 cu. ft.) of water per second. Each turbine is combined with a set of two three-cylinder high-pressure pumps for the oil feed, which supply 360 litres (80 gallons) of oil per minute. These are also constructed by Messrs. Escher Wyss and Co., and are driven by small Pelton wheels. There is a pressure-bearing between the turbine and generator, in addition to the foot-step, which has to support a load of 76 tons—the weight of the revolving parts. The new hydraulic mains leading to the power station have a length of 700 m. (0.44 mile), and a diameter of 1,300 mm. or 1,400 mm. (51 in. or 55 in.), like the old mains, but they are secured by stand-pipes, 150 metres in length. The mains alone weigh 5,000 tons.

The government has let the contract for the last section of the Hudson Bay Railway which it is hoped to complete by 1914. The last section extending, from Split Lake to the bay, is 165 miles long to Port Nelson and 245 miles long to Fort Churchill. This last link is to be built by Mr. J. D. McArthur. It is said to be the intention of the Hon. Frank Cochrane, as the result of his visit to Hudson's Bay, to run a railroad to the bay by electricity. A plant may be built at White Mud Falls, on the Nelson River. The Nelson River, he reports, has wonderful power possibilities, and could supply electricity to the whole of the West. The total available power is estimated at 6,000,000 horsepower.

A NEW TYPE OF SEWER PIPE.

Until the present time engineers in England and the United States have recognized the fact that some form of vitrified clay segment blocks for large sewers would be a most desirable material with which to construct large sewers and as a result of this fact many styles of segment sewer blocks have been invented. None have been successful for the reason that those which could be made economically of clay did not have any provision for end joints.

Those inventions which did provide for satisfactory form of end joints were of such a shape that they could not be made economically of clay. Therefore with the solution of the only objection that has arisen by providing a ship-lap joint for the ends of the blocks, which will hold a sufficient quantity of mortar so that a tight joint can be made and retained, the American Sewer Pipe Company of Akron, Ohio, have solved the problem and are presenting a successful vitrified salt glazed segment sewer block.

These blocks are made in one and two foot lengths, also in three different types, for construction of sewers ranging

Fig. 1.

from 30 inches to 108 inches in diameter; detailed description of each being shown in the enclosed table.

The material from which these blocks are manufactured are the celebrated Akron shale and Ohio River clays, which are acknowledged to be among the best adapted to the requirements of sewer construction, and when made in relatively thin sections, attain a perfect vitrification. In these blocks all the walls are of a thickness to which these clays best lend themselves for a perfect vitrification.

The outside surface of the blocks, being the part with which the sewage comes in contact, is the part requiring the highest glaze and it is possible to secure almost absolutely perfect glaze.

A test of Type A Block showed a crushing strength of 3,040 pounds per square inch, pressure being applied at weakest point, viz., between webs.

The end joint is made in the style of the ship-lap joint and is made possible by a web, or system of webs, which provides backing for the mortar and an annular space is secured which, when filled with mortar, produces a tight sanitary joint.

The mortar joints on the dove-tailed sides are scratched to assist in retaining the mortar. The blocks are made as large as can be conveniently handled and have an inside area of approximately 270 square inches each, thus eliminating, in a large measure, the objectionable feature of numerous joints.

The outer openings in the hollow block system of sewer construction are well adapted to carrying surface water and are also of special value to the contractor, when constructing a sewer in a wet trench, as, after the invert is laid a drain is effected which carries a large amount of water and leaves a perfectly dry sewer for construction of the arch. This obviates the necessity of laying under drains.

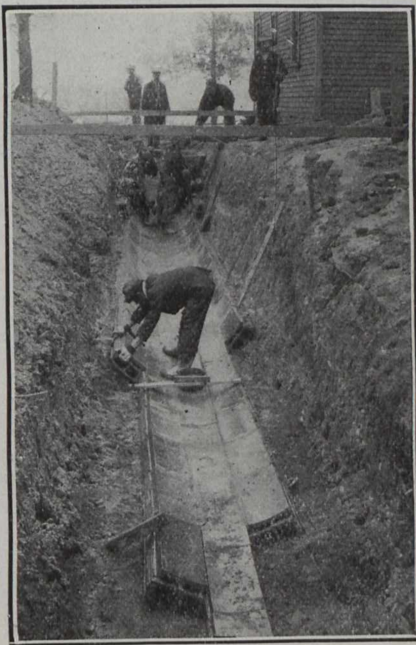


Fig. 2.

In soil where it is possible the trench is excavated as near the shape of the outer shell of sewer as possible, and the bottom of invert block laid ahead for drainage purposes and to proper line of grade. The successive tiers are thoroughly tamped at the back. A template is used as high as the spring line, after which a form for the arch is required and for which a collapsible

Fig. 3.

form has been designed which greatly facilitates the work. The male and female dove-tailed joints are so constructed that only the key block requires slipping in endwise. All other blocks drop into place on the side. After forms have been removed all joints are pointed and all spilled mortar removed from the inner surface of the sewer. The backfilling commences immediately upon collapse of form or as soon after as feasible. The earth is thoroughly tamped to fill voids from pulling sheeting.

At the discharge or spill end of sewer a concrete apron is usually installed to insure against washing away of tamping or foundation.

The city of Flint, Mich., recently completed a 42 and 48-in. outfall sewer built of salt glazed vitrified clay segment blocks. A construction view of this sewer is shown in Fig. 1.

Sewers built of these blocks in the manner described are said to be watertight. They also are as durable and impervious as vitrified pipe. The frictional resistance to the flow of water in these sectional block sewers is claimed to be considerably less than any other type of construction adapted to the same class of work. At the same time tests have shown that the load carrying capacity is large. The type of block construction here described is manufactured by the American Sewer Pipe Co., of Akron, Ohio.

KEEPING RECORDS OF MUNICIPAL IMPROVEMENTS AT FARGO, N.D.*

The city engineer's department has felt the need of complete and accurate maps of the city for all purposes, and I believe, and in some instances know, that serious errors have been made by relying on maps that were unreliable.

Two sizes of maps have been adopted for our use. A large map on a scale of 200 ft. to the inch shows all sections, quarter-sections, additions, streets, avenues, alleys, and blocks and lots. On these maps will be plotted all municipal improvements, such as sewers, water mains, sidewalks, paving, and such general information as can be of use. This size is for wall purposes.

A second size is made up on a scale of 100 ft. to the inch and each sheet contains one quarter-section, making the size of the sheet 26 x 26 in. On this map, in addition to data on the larger maps, are sewer wyes, sewer connections, water-main connections, valves, shut-off boxes, hydrants, paving, openings in paving and date made, cost of special improvements against each lot, sidewalks, new buildings, the lighting system and a great deal of minor data connected with the above. At present none of these data is collected in a compact form that can be used to any advantage and in that respect this department has not been kept up to the needs of the city. In no other way can such information be kept available for instant use than by progress maps. This work has taken a great deal of labor and painstaking research and when completed will form one of the most valuable records in the office.

There are no more valuable records in any engineer's office than progress records and maps, and this applies with great force to the work of municipal engineering. Data on work constructed and completed are wanted at all times by a great many people in all lines of business. Some desire data for mere curiosity; but the great majority want them because their business is more or less affected by such information. In many cases the health and safety of the public depend on the absolute correctness of the data. It seems a foolish policy for an office not to make a record of work done at the time it is done, when oftentimes such record can be correctly made at a small cost, when if left undone irreparable damage may follow. We have daily calls for information, that we should be able to give and that it is the function of the city to provide to its citizens, that cannot be given because of lack of records. It is the aim to eliminate this state of affairs as rapidly as is possible. The data must be picked up in all manners of ways and time is the greatest factor in its completion.

The lack of records in the office is an unfortunate condition that has hampered our work greatly during the past two years. Efforts to remedy this defect have in some cases proved effectual, but in other cases there is no remedy whatever. As such may be mentioned lack of actual cost of contract work, time when certain contracts were begun, progress of same and time of completion; surveys made, results and conclusions; location of monuments, opening in streets, street lines, grades for sidewalks and streets and data upon which made; data upon which sewer and water mains have been designed, and cost of office work.

A complete office system has been started in order to eliminate these defects in the records. The loose-leaf system is used throughout. The lack of notes on surveys, time the men were employed on any piece of work and sidewalk records, was most noticeable and this has been remedied. The loose-leaf system of field notes was adopted, and a filing system is used which I have every reason to believe is original. The field-note sheets are 4¼ x 7¼ in. These sheets are pasted on 5 x 8-in. division index cards which have the usual 5-cut tab. On this tab the character of the work is printed and the indexing completed. The time of men employed and any class of work is kept in a similar manner.

For the purposes of engineering the records of costs have been divided into heads as follows: Board of Health; Bridges; Dam; Maps; Monument Lines; Office Supplies; Park Commission; Paving; Pay Roll; Requisitions; Sewers; Street Grades; Street Lines; Waterworks; Water Mains and Sidewalks. Each of these is subdivided into two heads: (1) Construction, and (2) Maintenance. Each of these subheads is subdivided again into Labor, Material; Engineering and Estimates.

* From the report of the city engineer of Fargo, N.D., 1910-12.

TRANSPORTATION QUESTION IN CALGARY.

The proposed piping of natural gas to Winnipeg from the Bow Valley by Calgary capitalists, with four or five pumping stations, commencing somewhere about Swift Current, which would force the gas to Winnipeg, is meeting with various objections. Mayor Spencer, of Medicine Hat, objects to a charter being granted the new company, and the Calgary Herald demands either Provincial or Dominion prohibitive legislation.

The Interurban Railway Company is acquiring 13 acres of the industrial tracts owned by the city, for use as the site of a repair shop.

A mile of street railway track is to be built by the South East Calgary Corporation, from Ogden station to the city limits. This will be handed over to the city of Calgary in return for a service operated by the municipal system over the tracks of the South East Corporation.

Plans of the Western Dominion Railway Company, considered by the board of trade this week, have the name of J. E. Askwith as president. This did not, however, convey enough information to the committee, and they decided to recommend approval of the map filed provided the promoters could assure them of immediate construction. The line is variously ascribed to the Canadian Pacific Railway, Canadian Northern Railway and Great Northern interests. It will open a country between the international boundary and the Peace district (passing through Calgary), which contains a vast area of clays, shales, coal, natural gas, tar, sands, and possibly oil.

A NEW SYSTEM OF ILLUMINATION TO AVOID GLARE BY DIFFUSION.*

By Hans K. Ritter, E.E., Assoc. Mem. A.I.E.E.

There are three distinct devices which are utilized to make up a modern illuminant: First, the source of light or lamp; second, the reflector or redistributor of light; third, the diffuser or softener of light.

It is the combination of these three devices into an efficient unit, its framing into a supporting structure or fixture, and the final application to our many varied needs, that are the problems of the illuminating engineer of the present day.

The tungsten lamp, mercury arc, etc., have all distinct distribution characteristics of light flux emitted by them, inherent to them; that is, they are dependent on the mechanical arrangement of the light-emitting surfaces. These characteristics cannot in general be adjusted so that a fully satisfactory light-distribution for all the necessary applications of the lights is found. To accomplish the latter, the first accessory mentioned, the reflector, is now universally used.

Most modern illuminants have such a high intrinsic brilliancy that a correction is necessary to make them agreeable to our eyesight. To accomplish this, diffusing envelopes, such as globes, spheres, etc., are widely used.

At the present time, it is common practice to combine lamp and reflector, or lamp and diffusing globe. To combine lamp, reflector, and diffuser efficiently, many difficulties arise, as all know who have seriously attempted to make this combination. The failure to create such a unit accounts for the deficiency of many lighting installations.

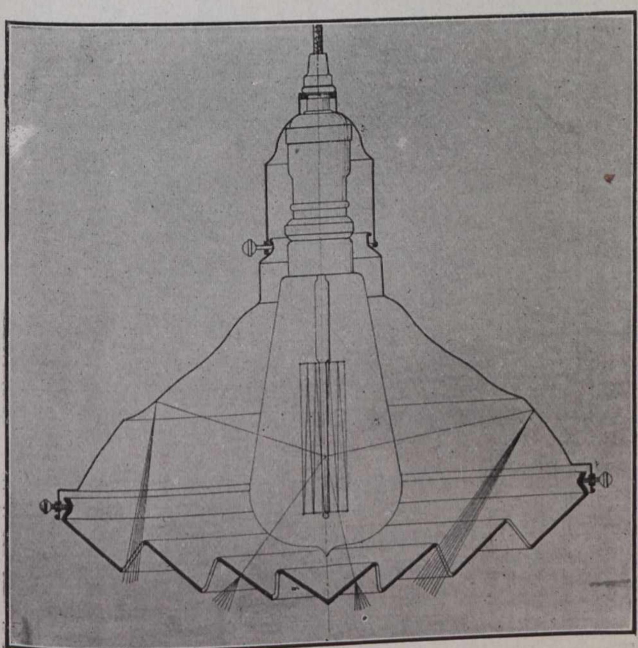


Fig. 1.

My experience shows me that it is a comparatively easy matter to make a reflector for a certain redistribution of light, but a much harder task is set if the reflector is to act as diffuser and efficiently shield the glaring source of light.

Most of the diffusing globes diffuse the light, but have no action in redistributing it efficiently.

However, to make certain a fully satisfactory arrangement, we are bound to combine lamp, reflector, and diffuser into one unit, and only so are able to produce an illuminant which is hygienic and fully satisfies our demands for ease and comfort.

Many attempts have already been made to successfully solve this problem. The most common of them is the frosting of the electric lamp bulbs; but this remedy cannot be said to fully cover this problem, as the frosting leaves the reflector surface unscreened within the field of vision, and even then the lamp's intrinsic brilliancy is high. Incidentally, sand

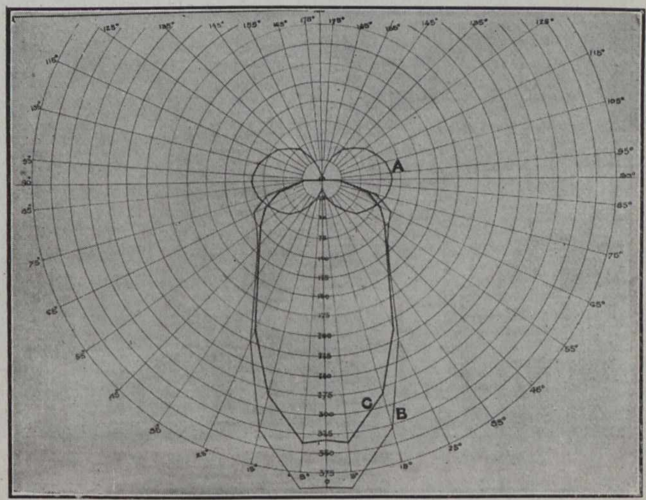


Fig. 2.

blasting the bulb tends to diminish the effective life of the lamp, reducing it to some degree and, according to several authorities, to a large extent. It is therefore better to use clear glass bulbs, screened by a diffusing envelope large enough to keep the intrinsic brilliancy down. Another method employed to screen the source of light is by means of indirect illumination. An investigation of this method shows that it cannot be generally adopted, as its applicability and efficiency, in most cases, are dependent on the preparation of ceilings and walls.

It was about the time when the Nernst lamp was at its height, and especially used for better lighting, that in the firm of Messrs. Ritter and Uhlmann, in Basel, fixture manufacturers of note in Switzerland, research tests were conducted under the direction of Mr. J. J. Ritter to find an arrangement which would embody in an efficient and proper manner the three fundamental components, namely, lamp, reflector, and diffuser in one unit, combined.

Especially the relation of many problems which arose in the practical and artistic application of fixtures to illumination and which had to be solved, was responsible for the creation of many new shades and types, and our efforts resulted finally in the invention of the combination that I am describing, patented in this country as well as abroad.

In principle, this combination comprises an upper reflector and a lower glass distributor or diffusing envelope. These totally enclose the light source in such a manner that no direct rays from the filament leave the fixture without coming from one or the other of the supplementary diffusing surfaces, the attached translucent glass, or the matt reflector within.

The lower disc, as you will see in the cut, Fig. 1, is made up of concentric, truncated cone surfaces, alternately erect and inverted. This embodies the fundamental principle of this invention. The inwardly sloping surfaces of the inverted cones are matted. The outwardly sloping surfaces of the erect cones are of clear glass.

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*Paper read at the Annual Convention of the Illuminating Engineering Society, Niagara Falls, Ontario.

Direct rays of the filament pass through the inwardly sloping cone surfaces of the diffuser, which are matted so as to completely hide the source of light. While this translucent surface hides the image of the filament, it is not dense enough to affect the efficiency greatly.

Rays which do not go directly from the filament to the diffuser, strike the reflector surface. From this they are reflected back downward and pass out through the outwardly

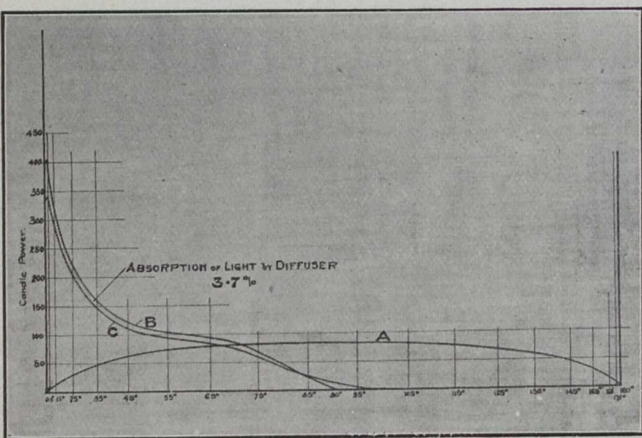

Fig. 3.

sloping cone surfaces of the glass, which are clear. Again, those rays which are reflected from the matted surface of the diffuser, strike the reflector, and from there pass out through the clear glass of the diffuser. I am inclined to think that this class of rays deserves more attention than is usually given to it, and that it adds materially to the efficiency of the combination. A maximum outlet for the whole spherical flux is thus provided through the lower surface, most of the light undergoing only a single diffusion. This, in addition to the correct matting of the translucent surfaces, contributes to the unusual high efficiency of this combination.

In Fig. 2, the polar diagram, curve A, shows the shape of the distribution curve for a 100-watt lamp without accessories; curve B, when a matted aluminum reflector is employed, and curve C shows the effect of the diffuser added.

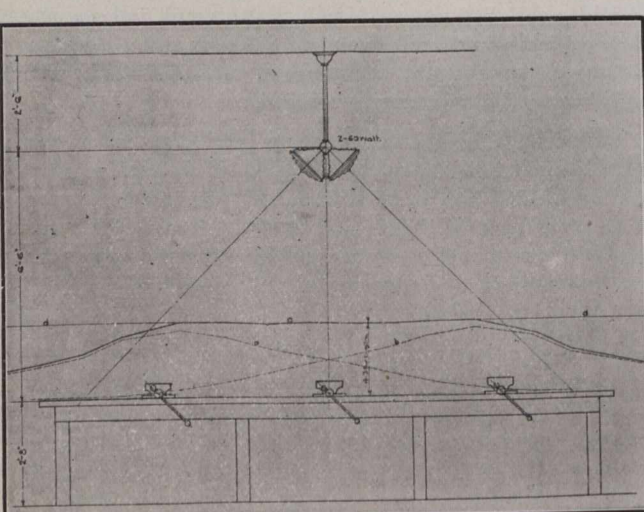

Fig. 4.

Any desired light distribution can be effected, as this depends entirely on the shape of the reflector and the position of the lamp in relation to it; not on the diffuser, as some might expect.

From the Reousseau curve (Fig. 3), you may note that the absorption of the diffuser amounts (curve C) to 3.7% of the total light flux (curve A).

But the efficiency is supplemented by other favorable points in this combination. The unit is practically dustproof. No dirt can hang on to the inner diffusing or reflecting surfaces, so the maintenance cost is low.

The size of the diffusing envelope depends upon the size of the lamps used, so that for a small lamp small units are fabricated and for large lamps, large ones.

Before I go over to the practical application of this unit as an efficient illuminant for the lighting of working planes, I wish to emphasize that from no point beneath the fixture can the filament itself been seen through the clear glass surfaces. Eye protection is therefore afforded to the fullest extent.

Innumerable applications can be made of this unit when suspended vertically; but with the advent of the wire-type tungsten lamp no necessity exists to use these lamps only in a vertical or upright position. By means of the patented diffuser described, we can with equal efficiency employ the lamp at any desired position.

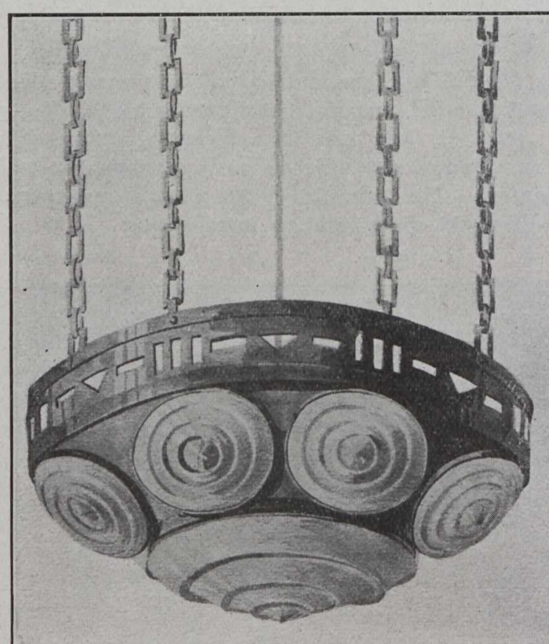

Fig. 5.

It is widely known that a series of sources of light, distributed in a given space and employing one type of reflector hanging vertically, give an even light distribution only when given a certain spacing distance and placed above a certain height.

For a light source in a reflector placed on an angle, the light distribution being of the focusing type, it is different. Here we are only concerned to find the angle which would correspond to an even illumination of a zone on the working plane, and any lowering or raising of the fixture does not affect the even distribution of light in one zone on the working surface. In Fig. 4 such a condition is shown. By the point-by-point method the illuminating values are projected on the working plane and the resulting illumination values computed.

A material saving of light is thereby effected, as the highest intensity is actually brought in the working zone. Further, by using a cluster a saving of outlets required, results.

For instance, in the conditions considered, two 60-watt lamps, each placed in a unit as described and standing at

45° against the vertical, thus being grouped as a cluster, the spacing distance would be about 15 ft., with a vertical hanging distance of 6 ft. 6 in. from the working plane.

In Fig. 5 a fixture is shown built up of the above units, which is designed for use as a church fixture. This fixture is built up of the following: First, a group of six diffusers placed at 45° to the vertical, each 12 in. in diameter, and enclosing one 100-watt tungsten lamp; second, one diffuser placed vertically 16 in. in diameter and holding three 100-watt tungsten lamps; third, three reflectors each holding one 60-watt tungsten lamp, these being used for ceiling illumination.

From the picture it can be noted that the framework of the fixture is such that the reflectors are hidden from view. The bulb, also, of the electric lamp, which as I found really never adapted itself to be brought into an artistic shape, is covered up and a compact and efficient arrangement is found in which all parts serve a useful purpose, readily adaptable to decoration.

Many styles of fixtures can be created, almost all of which appear artistic and attractive in form.

The principle laid down through the combination of lamp, reflector and an efficient diffusing envelope is not exhausted. The field for application is a very large one to employ these means to eliminate glare. The combinations and applications of these units are so numerous that it is almost in order to call it a new system of illumination created through the employment of a diffusing envelope having a very high efficiency in connection with reflector into one unit.

To recapitulate, we have in this system:

(1) Means provided to reduce the intrinsic brilliancy of a source of light to any desired extent.

(2) The disc, being of flat shape, adapts itself admirably for building fixtures to give any desired lighting or artistic effects.

(3) The reflector unit, being totally enclosed, makes it practically dustproof, which means minimum attention after installation.

(4) On account of its independence upon actual surroundings it has a very large field for application.

(5) Our experience in Europe shows that the high commercial efficiency, together with the small attention required after installation and the low cost of installation, more than offsets the slightly higher factory cost.

AMERICAN ROAD CONGRESS.*

By E. A. James.†

The American Road Congress, a conference composed of road users, road builders and road machinery men, held at Atlantic City, October 1st to 5th, was successful beyond expectation. Although held at the very busiest season of the year, yet the attendance was large, the exhibits varied and extensive and the papers and addresses of a high order.

In the exhibition hall the exhibitors of the United States Road Department and of the various state departments clearly demonstrated the progress being made in highway construction, both in theory and practice, while the displays by the manufacturers show clearly that they appreciate the large field opening in road work on this continent.

The delegates were welcomed by Woodrow Wilson, Governor of New Jersey, and in view of his place in the public mind at the present some of his remarks are of unusual interest. Governor Wilson said in part:

"The question of highways is a question which has interested by thought, particularly in recent years, because it is one of the few great instrumentalities of our public life and of our communial life with which the government is of necessity connected. The government is not, in the United States, expected to build railroads. The government is not as yet expected to own railroads. Railroads differ from other highways, though we often speak of them as the highways of our commerce, in this important particular, that only those who own them can use them in the matter of putting vehicles upon them—that a particular set of individuals by reason of their control of the road, have the exclusive right-of-way over it.

"We must more and more engage the government in providing the general facilities of the common life. There is no breach in that of any of our older understandings of the function of government. We have never doubted that the government had the right to supply these facilities which private endeavor has never been expected to supply. Therefore, we are not upon a new ground of theory; we are merely upon a new ground of tactics, and when I think of what the highways mean, I seem to be thinking of the whole history of the human race. Whenever I used to read stories I remember my imagination was most fascinated when the characters went on a journey and met the rest of the world.

"On the old highway, particularly the old English highways, you met everybody from the King to the beggar, from the King to the highwayman. You were there in a way to have the adventure, the whole experience and adventure of English life, because it was there that English life interlaced and crossed and was fluid, flowing from one region to another, and by the same token it was upon the highways that men got the contacts which result in the building up of public opinion.

"I was trying to illustrate the fact one day that in some of our great cities there is no public opinion, in a way which led me into trouble. I said, that what generally happened to a man in a city was that when he got in a public vehicle or on a highway, he doesn't talk to anybody, but if he can hold himself steady enough, that wherever he happend to be he plunges his head into the morning newspaper and experiences a reaction which he calls his opinion, but it is not an opinion at all, it is simply the impression that a piece of news or an editorial has made upon him and he cannot be said to be participating in public opinion or in opinion at all until he has laid his mind alongside the minds of his neighbors and discussed with them the incidents of the day and the tendencies of the time.

"Where I got into trouble was, that I ventured to use this illustration. I said that public opinion was not typified on the streets of a busy city, but was typified around the stove in a country store where men sat and probably chewed tobacco and spat in a sawdust box and made up, before they got through, what was the neighborhood opinion both about persons and events; and then, inadvertantly, I added this philosophical reflection, that whatever might be said against the chewing of tobacco this at least could be said for it: that it gave a man time to think between sentences. And ever since then I have been represented, particularly in the advertisements of tobacco firms, as in favor of the use of chewing tobacco.

As a means of reflection, I dare say that it is wholesome; otherwise I will not declare my opinion about it at all.

"But the illustration, nevertheless, was an illustration of what I think is pertinent to us, or rather pertinent to my thought in connection with what you are doing. You know

* *The Canadian Engineer* will publish from week to week verbatim reports of the more interesting addresses.

† Engineer for the York Highway Commission.

how the Roman empire used to throw its great highways out from Rome until they touched the limits of the empire—until they threaded even the distant island of Britain; and it was like throwing thongs out to bind all the empire together. Now, the initial purpose of those highways was to afford an open road for the armies of Rome so that she could throw her power rapidly in any direction; but Rome also, in my imagination at any rate, prepared her destruction by those highways because she could not open them to her own armies without opening them also to the people that lived upon their edges, and they could not touch one another without forming an opinion about the Roman power, without intermingling the influences of different nations, for these roads did not stop at national confines, and the Roman roads threaded the opinion of the world together into an axus and pattern, and I tell you very frankly that my interest in good roads is not merely an interest in the pleasure of riding in automobiles, it is not merely an interest in the very much more important matter of affording the farmers of this country and the residents in villages the means of ready access to such neighboring markets as they need for their economic benefit, but it is also the interest in weaving as complicated and elaborate a net of neighborhood and state and national opinion together as it is possible to weave.

"It is of the most fundamental importance that the United States should think in big pieces, should think together, should think ultimately as a whole, and I felt, in my enthusiasm for good roads something of the old opposition that there always has been in me to any kind of sectional feelings, to any kind of class feeling.

"The reason that city men are not more catholic in their ideas is that they do not share the opinions of the country, and the reason that some countrymen are rustic is that they do not know the opinion of the city and they are both hampered by their limitations. I heard of a lady the other day who had lived all her life in the city and in a hotel. She made a first visit to the country and spent a week in a farmhouse. She was asked afterwards what interested her most about her experience and she said that it was hearing the farmer page his cows.

"A very urban point of view with regard to a common rustic occurrence, and yet that language showed the sharp, the inelastic limits of her thought. She thought much more narrowly than in the terms of a city. She thought in the terms of a hotel; and in proportion as we are confined within the walls of one hostelry or city, or one state, we are provincial, and national thought cannot successfully build itself upon those foundations in a way that will be permanent; so that I believe that the development of great systems of roads is, psychologically speaking, as well as physically speaking, a task of statemanship.

"I believe that it is the proper study of the statesman to bind communities together and open their intercourse so that it will flow with absolute freedom and facility. No one argument ought to be omitted; every class has its argument for good roads, and putting them all together they form an irresistable mass of arguments, but the result of the whole reasoning to my mind is simply this: the United States has up to this time simply let the energies of the people drift.

"It has thrown the reins on our necks and said, 'Now, here is a continent of unexampled richness; do what you please with it. We will try to see that you don't break each other's heads. We will try to see that you are restrained until you get so powerful that we can't restrain you. We will try to see that you do justice until you so combine with one another that justice is impossible, but we are not going to lend the aid of the government to the actual task of development.'

"That has been the general attitude of our government up to this time. It cannot be that attitude any longer. There are things of this sort for example, you take not merely the matter of good roads and the carrying of goods to market, but of what goods there are to be carried to market, the production, the agricultural production per acre in the United States does not favorably compare with the production per acre in the older countries of the world and the margins are approaching one another.

"We used to lead the world and our grain exports were our chief exports, but the exports of grain are going down and down because the other margin is coming up, the margin of domestic demand and the population is increasing faster than the product so that a great deal of our commercial history is about to be altered by the circumstances of agricultural production, and I believe that it is the proper function of the government to see to it that by the extension of all the varied modern knowledge about agricultural process and about the characteristics of different soils ought to be so extended, so carried everywhere to the farmer as to build up by the aid of the government this thing that feeds us and ought to continue to feed the world; and whenever you speak of that, whenever you increase what the United States is doing, you must immediately increase the facilities of the United States for handling what it has made after it has made it. You cannot rationally increase the prosperity of this country without increasing the road facilities of this country."

"I remember having a very interesting and, for me, enlightening conversation with a mountaineer once in the North Carolina mountains. He was very hot against the excise taxes which made it practically impossible for him, without becoming a criminal, to make whiskey out of his corn, and I discussed it somewhat minutely with him in order to get his point of view. His point of view was simply this; he had a little farm that was a fertile pocket in a remote part of the mountain. It didn't pay him to take his corn to the market as corn, because by the time he got to the market, the very horses that were hauling it would have eaten it up, but he could profitably get it to the market as whiskey.

"His point was simply this, that it was unreasonable for the government to forbid his getting a market for his corn in the only way in which it was possible for him to get a market. Now, while we might say that it was not desirable that there should be any market at all for the product that he wished to sell, nevertheless, the illustration will point my moral, namely, that it is not worth while producing until you can release what you produce and that the only way of releasing it is by the most facile methods of inter-communication and transportation.

"We are merely threading the energies of a nation together, linking them in a single pattern, or rather, we are merely setting them free when we facilitate and promote the interests of a congress like this. I need not tell you, therefore, that I am in deep sympathy with the purposes of this congress, because in my judgment that would simply be like claiming that I was a rational being and I hope that does not require argument.

"I would rather admit it than try to prove it, and if you will allow me to admit I am a rational being, you will allow me to say that as a matter of course, I am profoundly interested in the purposes of this congress, and I consider it an honor that the State of New Jersey should have the pleasure of housing you for a little while and entertaining you for a little while in consultation about what is, at bottom, a great national interest."

Good Roads an Economic Necessity.

Dell M. Potter, Arizona and California:

"I do not own an automobile," said Mr. Potter, "nor do I own stock in any automobile corporation, but I know that the men who have money own automobiles, and if you want to get them into your States and have them learn the climate and soil conditions, together with their other attractions, you must furnish good roads upon which they may travel in comfort. The prosperity of the country depends upon the automobile, and the sooner we come to a realization of this fact the better it will be for us. Governor Wilson rightly said in his speech of yesterday that there is a limit upon farm products in this country because of poor roads. The roads of our country are in worse condition than those of any nation of the world. The policy of this United States Government as it affects the prosperity of the country is a thing wonderful to behold.

"Within the past year we have driven out of the great Northwest from 25,000 to 40,000 of our best citizens because they were not able to make a living on their farms, and all that prevented them was the vile condition of our roads. Nine-tenths of the money appropriated by Congress for public improvements goes into our rivers and harbors and but a small fraction into good roads. I have no fault to find with the practise of appropriating money for the rivers and harbors, even though it does benefit only the great corporations, but I contend that it is time the niggardly policy maintained towards our highway system was abandoned.

"There are 850,000,000 acres of farm land in this country and less than half of it is under cultivation, because of the inability of those who would work the land to get their produce to a market. Upon the products of these farms depends the prosperity of the country, and good roads are vitally essential to such production."

Marking Highways.

As a preface to his address on the establishment of a National Department of Highways, Frank D. Lyon told of the plan adopted in New York of designating various routes through the State by colors, and of the use to which telegraph and telephone poles were put in this connection. By this system, he said, it was possible for tourists to make their way from one point to another throughout the State without the aid of books or maps. Then, launching into his scheme for the establishment of the Federal Department for the supervision and construction of roads, he elaborated upon the plan and explained many of the details as they had been worked out by him. With the establishment of such a department, he said, its head could go from State to State, urging the establishment of similar departments and guaranteeing Federal aid in the construction of whatever roads were considered necessary. Whatever highways in the various States were designated as national highways would be maintained by the State and Federal Government sharing equally in the expense. The plan so appealed to the delegates in attendance that it was freely predicted some definite scheme towards its adoption would be worked out before the congress came to a close.

Maintenance of Roads.

It was admitted by all that American road systems were failing because of poor maintenance.

Logan Walter Page, president of the congress, was enthusiastic in reference to work accomplished. He said in part:

"Never before have there met in this country so many people or so many interests having for their object the betterment of the public roads. When we consider the great activities manifested during the last few years for the promotion of this most necessary work, it is astounding that so much has been accomplished in so short a time. As a matter of fact, more has been done in the last two decades than in the previous two thousand years. It engenders something more than the methods of construction and maintenance. Back of these problems are intricate questions of finance, which are involved in the issuance of bonds, the levying and apportionment of taxes, the accounting and safeguarding of road funds. Co-ordinate with the question of finance we may place those of promotion, legislation, organization, administration, construction and maintenance. Probably few other questions have been productive of so much legislation as that of roads. It is absolutely essential to sound progress in the road movement in this country that our highway be simplified and perfected.

"It is not admitted that the policy of placing convicts at work in the construction of roads or the preparation of road materials is wise in all cases.

"Although it is generally conceded that the most serious defect in our road system in this country is lack of maintenance, we have been making progress at a very slow rate to remedy this defect. It is high time that action is taken leading to a strong, concentrated and intelligent campaign in every State, not only in the maintenance of our roads in the highest state of efficiency, by the enactment of legislation that will provide definite annual appropriations and continuous and skilled attention, but the administrative phase of the question as well."

The speaker declared that the road situation, as it is to-day is that "we have two million and a quarter miles of public roads, eight per cent. of which have undergone some measure of improvement or have had something done to them; of this eight per cent. of so-called improved roads, probably not more than a half of four per cent. of the total, really deserve to be classed as improved roads. If we accept the general assertion that twenty per cent. of the roads carry ninety per cent. of the traffic, it follows that we have before us for improvement sixteen per cent. of the total mileage of the country, or 360,000 miles."

He asserted that the annual expenditures for this work in the United States was but half that spent by the United Kingdom on its 150,000 miles of roads; allowing but $417 per mile, or hardly enough for maintenance alone. "When we consider that a very large percentage of the $150,000,000 appropriated for this purpose is wasted, not so much through dishonesty as through ignorance and defective administration, it is apparent that the actual amount expended usefully on the roads is far less than the figures show. I believe that proper administration would save the country annually $40,000,000 of this amount and do the same work that is now being accomplished."

One of the most interesting resolutions proposed was the following:

"Resolved, that the president of this American Road Congress appoint a committee of five to formulate and suggest to several highway associations of the country, a proposed form of legislation to regulate and control the use of the public roads and highways by the automobile truck and other self-propelled trucks and traction engines; to the end that the good roads of the country may be protected from the present destructive tendency of their use by excessively large and heavily loaded vehicles of the class herein described, and for the further purpose of obtaining a general expression of opinion on this subject which may result in uniform legislation throughout the several States to regulate the same."

It is fortunate that action is being promptly taken in connection with this important feature of highways before the vested interest becomes too large.

Mr. W. A. McLean, provincial highway engineer for Ontario, gave a very interesting address on "Road Improvement in Canada." *The Canadian Engineer* expects later to publish this address in full.

COAST TO COAST.

Porcupine, Ont.—The gold shipped from this centre in September will aggregate $500,000.00.

Toronto, Ont.—Fifteen young men of the forestry class, University of Toronto, have left for the study of practical forestry on the shores of Lake Nipegon.

British Columbia.—In order that the $2,000,000 bridge to be erected by the Canadian Pacific Railway across the Pitt River may be started, a large bridge now in use will have to be removed.

Ottawa, Ont.—The management of the Ottawa Light, Heat and Power Company will apply at the next session of the legislature for power to increase their capital from $2,000,000 to $5,000,000.

Guelph, Ont.—The past year has been an excellent one in building circles, as may be readily seen in the report of the city engineer's department. Over one hundred houses, with a value of $294,961.00 have been erected. The total building permits are over $500,000.00.

Montreal, Que.—The harbor commissioners' new grain elevator, officially opened by Hon. J. D. Hazen, October 2nd last, has a length of 456 feet, a width of 100 feet, and a storage capacity of 2,620,000 bushels. It is the largest concrete grain elevator in the world. A complete description of the elevator appears in *The Canadian Engineer* of October 3rd.

St. John, N.B.—New rates for electrical power in this municipality have been published as follows: On installation of 25 h.p. with a base rate of ten cents per kilowatt monthly consumption of not less than $70, 33 per cent. discount; $84, 36 per cent. discount; $100, 39 per cent. discount; $125, 42 per cent. discount; $140, 45 per cent. discount. Additional discount of ten per cent. from the net amount (for cash) if paid within ten days of presentation of bill, is authorized.

Vancouver, B.C.—The survey is completed for the double tracking of the C.P.R. between Calgary and the coast, and work will be commenced at twelve points on the route within six months. The construction will be rushed as swiftly as possible and there is a prospect that the line will be completed almost as soon as the Panama Canal is open for traffic. The second line will be approximately parallel to the present main line of the C.P.R., but the grade through the Rockies will be materially reduced. The cost of the undertaking is estimated at aboue $30,000,000, the expenditure in some districts exceeding $100,000 per mile.

Toronto, Ont.—As a number of parties have requested that the time be extended for the return of the comments respecting the proposed rules and regulations for inside wiring, the Hydro-Electric Power Commission of Ontario have consented to the extension of the time for the return of such comments to the 1st of December next, 1912. Comments should be forwarded to Mr. W. W. Pope, secretary, Continental Life Building, Toronto.

Toronto, Ont.—Professor L. B. Stewart, of the University of Toronto, who has spent the last four months in the district of Patricia, the five-mile strip on Hudson Bay recently added to the Province of Ontario, has returned to Toronto. During the summer he has been engaged in surveying and laying out a portion of the new district. While the land within fifty or sixty miles of the Bay is mostly marsh and muskeg, the swamp is not of any great depth, and Professor Stewart is of the opinion that it could easily be drained and would offer no serious obstacles to railroad construction. Engineers of the Hudson Bay Railway are in the field locating a line, and contractors are at work grading from Pas Mission northward for several hundred miles.

Fredericton, N.B.—It is reported that the Grand Falls Company, Limited, the new company headed by Sir William VanHorne, which is to spend upwards of $8,000,000 in the development of the water power at Grand Falls and the erection of vast pulp and paper mills, is making the first move towards commencing with its undertaking. At the present meeting of government an order-in-council is being passed empowering Hon. J. K. Flemming, as surveyor-general, to convey by deed to the company the water power and five acres of land along the banks of the river upon payment of the sum of $60,000. Below the falls only one-half the river can be conveyed to the company, the other half being held by the Crown for ordinance purposes. Recently the government was notified that the Grand Falls Company, Limited, was prepared to pay over the $60,000 and take a deed of the property and rights and the deed has been prepared by Attorney-General Grimmer and will probably soon be executed.

Grand Trunk Pacific.—Rapid progress is being made with the construction of stations along the main and branch lines of the Grand Trunk Pacific Railway, and an effort is to be put forth that will result in a station being erected at every stopping place from coast to coast with the completion of the line. Out of a total of 237 stations, 79 have been completed, 58 are in various stages of construction, while 100 remain to be erected. The work on the construction of the G.T.P. stations is as follows: Main line, Winnipeg to Fitzhugh, 159 stations, 69 completed, 44 under construction, and 46 not started. Yorkton branch, 10 stations, 2 completed, 5 under construction, and 3 not started. Regina branch, 17 stations, 4 completed, 3 under construction, and 10 not started. Calgary branch, 32 stations, 4 completed, 3 under construction, and 25 not started. Prince Albert branch, 19 stations, 3 under construction, and 16 not started.

Montreal, Que.—The gates of one chamber of the St. Gabriel lock in the Lachine Canal at Montreal were wrecked September 24 by a boat collision that resulted in draining the adjacent upper level of the canal and caused a total interruption of navigation. The two chambers of the lock are side by side just below the Rue des Seigneurs swing bridge. Below them the basin is crossed by the Wellington Street swing bridge. The steamer "Glenmount" had just passed through the lock and the upper swing bridge, leaving the upper gates still open, when the steamer "Nevada," also up-bound, ran into the lower gates and tore them from their hinges, allowing the water from the upper level to escape in a wave 9 ft. high into the lower level. The flood tore one of the upper lock gates from its hinges and carried it, together with the two lower gates, into the lower level of the canal. Although her engines were in operation the "Nevada" was unmanageable and was turned completely around and carried up against the bank at the lower end of the basin, while the "Glenmount," also under steam, was swept down through the lock into the basin. A barge heavily loaded with sand was torn from its anchorage above the upper bridge and swept through the lock and basin to the lower swing bridge, where it brought up against the fender and bridge girders, doing some damage. A diver and derrick boat have been put at work in the basin to attempt to raise the gates and replace them. A portion of the gate gears that were torn from their frames have been found uninjured and it is hoped that the gates will be found serviceable.

Toronto, Ont.—The long-pending arrangements for the construction of a union station at Toronto, Ont., seem destined to further delay. Following a conference last week the Railway Commission has called on the Grand Trunk and the Canadian Pacific to present within three weeks a joint statement showing the exact status of the negotiations between the two companies regarding the project. In the meantime the railways announce that they will have entered an appeal to the Governor-General in Council against the viaduct order, thereby re-opening the whole viaduct and union station issue. The Canadian Pacific declares that it is not party to any order respecting the union station yet made by the Commission and therefore is not subject to the present order. The road's counsel declared that the determination of the plans for the union station depended entirely on whether or not the viaduct scheme was to be carried out, and reiterated the unalterable opposition of his company to that scheme. The plans could not be decided until the track level was fixed. It is expected that the railways will ask for the appointment of a board of three independent engineers of acknowledged eminence to prepare a joint recommendation. Such a board could report in time for work to be begun in the spring.

ROYAL ARCHITECTURAL INSTITUTE.

The Royal Architectural Institute of Canada opened its seventh annual meeting in Ottawa on October 7th, addresses of welcome being extended by Mayor Hopewell and C. P. Meredith, president of the Local Chapter of the Ontario Association of Architects.

The Institute will meet next year in the city of Calgary. A resolution was passed by the Institute reorganizing it as the representative body of the Federated Provincial Associations. The Royal Architectural Institute of Canada has a membership of 550 in all parts of Canada.

F. S. Baker, president of the Institute, retired, and the following officers were elected: President, H. C. Russell, of Winnipeg; vice-presidents, Messrs. George Long, of Calgary; A. F. Wickson, of Toronto, and G. A. Monette, of Montreal; honorary secretary, Alcide Chausse, Montreal; honorary treasurer, J. W. H. Watts, Ottawa.

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MANITOBA ASSOCIATION OF ARCHITECTS.

The annual meeting of the above was held in Brandon, Man., on Saturday, September 28th last. The following were elected officers for the coming season: President, W. Fingland; vice-presidents, W. A. Elliott and J. Prender West; secretary, R. G. Hanford; treasurer, W. F. Nichols. Several important questions were dealt with, including the new Winnipeg building by-laws, the Selkirk memorial competition and the annual meeting of the Royal Architectural Institute of Canada, to be held in Ottawa in the near future.

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ONTARIO SOCIETY OF ARCHITECTS.

At a meeting of the Ontario Society of Architects the following were elected officers for the coming season. The annual convention of this body will meet in the city of Ottawa during the middle of October. President, C. P. Meredith, Ottawa; first vice-president, Jules F. Wegeman, Toronto; second vice-president, A. C. Bond, Toronto; treasurer, J. P. Hynes, Toronto; registrar, H. E. Moore, Toronto. The other members of the council are: Professor Wright, Toronto, and Fennings Taylor, Ottawa.

CANADIAN STREET RAILWAY ASSOCIATION.

The Canadian Street Railway Association met last week in London. A number of papers were read by members of the association, and officers were elected for the year as follows: President, Mr. Patrick Dubee, Montreal; vice-president, Mr. C. B. King, manager of the London street railway; secretary-treasurer, Mr. Acton Burrows, Toronto; executive committee, the officers and Messrs. R. Hooper, St. Johns, N.B.; J. E. Hutchinson, Montreal; J. D. Fraser, Ottawa; W. Phillips, Winnipeg, and J. E. Coleman, Hamilton.

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REGINA ENGINEERING SOCIETY.

The Annual Meeting of the Regina Engineering Society was held last week and the following officers were elected. No new nominations were offered and the men who have served during the past five months of the society's existence were unanimously re-elected. They are as follows: Hon. president, J. G. Sullivan; president, A. J. McPherson; first vice-president, H. S. Carpenter; second vice-president, L. A. Thornton; secretary, J. A. Gibson; treasurer, E. I. Wenger; corresponding secretary, R. O. Wynn-Roberts.

The address of the evening was a paper on "Good Roads," read by A. J. McPherson.

Mr. McPherson reviewed the history of road making in Saskatchewan, but dealt chiefly with the progress which had been made since 1906 and the methods adopted. His paper dealt with the whole question from the standpoint of the government, and showed what progress had been made since the adoption of the first policy of having the money provided for this purpose expended under local supervision, which resulted in its being done only when no other work could be undertaken, through successive steps up to the present system under which the supervision of the making of main roads is entirely under the supervision of the commission. He showed how the steps which had been taken had resulted in having a large body of men scattered over the province, all of whom were intelligent road builders.

The work of construction, when of any extent, such as construction of roads through sloughs, through rough country and the building of bridges over twenty feet span, is done by the government while the maintenance of roads built with government assistance and the upkeep of the ordinary roads is left to the municipalities.

In the discussion which followed the paper Mr. Carpenter drew the attention of the engineers to the fact that there was a dearth of road engineers throughout the country and that many municipalities were refraining from entering upon extended plans of road building because they could not get men competent to direct the work.

PERSONAL.

MR. LOUIS B. STEWART, Professor of Surveying of the University of Toronto, who has been north for the Dominion Government, settling the boundary between Manitoba and Ontario, is back in Toronto.

MR. WILLIAM KENNEDY, JR., of Montreal, will in all probability be retained by the fire, water and light committee of Winnipeg as consulting hydraulic engineer in connection with the Point du Bois power plant.

MR. G. C. BATEMAN, B.Sc., late of the staff of the Dome Mines, in Porcupine, has been appointed to succeed Mr. A. D. Miles as Canadian representative of the Canadian Mining and Exploration Company. Mr. Bateman is a graduate of Queen's University, and is an experienced mining man.

MR. PATRICK WELCH, of the firm of Foley, Welch and Stewart, has resigned from the vice-presidency of the Pacific and Great Eastern Railway Co., and has secured the contract to build this line throughout its length from North Vancouver, B.C., to the Grand Trunk Pacific main line. Mr. Welch has established headquarters at Lillooet and will begin operations immediately.

MR. LOUIS B. STEWART, Professor of Surveying of the Canadian Society of Civil Engineers, has been appointed by the Government to investigate work done in the construction of the National Transcontinental Railway under the old commission. An investigation has been in progress for some months by George Lynch Staunton, K.C., of Hamilton, and F. P. Gutelius, formerly with the C.P.R.

COMING MEETINGS.

THE CANADIAN HIGHWAY ASSOCIATION.—Meeting will be held in Winnipeg, Man., October 9th to 12th. Secretary, P. W. Luce, Room 4, Cunningham Block, New Westminster, B.C.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.—Annual Convention will be held at Baltimore, Md., October 15th to 17th, 1912. Secretary, C. A. Lichty, 226 Jackson Blvd., Chicago, Ill.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Annual Convention to be held at Dallas, Texas, November 12th to 15th, 1912. Secretary, A. P. Folwell, 50 Union Square, New York.

AMERICAN RAILWAY ASSOCIATION.—Nov. 20th. Annual Meeting at Chicago, Ill. Secretary, W. F. Allen, 75 Church St., New York.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Ninth Annual Convention will be held in Cincinnati, December 3, 4, 5 and 6, 1912. Secretary, E. L. Power, 150 Nassau St., New York.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 409 Carter Cotton Bldg., Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.: Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy: Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

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